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Studies in the
Artificial Digestion of Meat

Chemistry

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STUDIES
IN THE
ARTIFICIAL DIGESTION OF MEAT

BY

DONALD S. MILLER, B.S., 1906

THESIS

FOR THE

DEGREE OF MASTER OF ARTS

IN THE

GRADUATE SCHOOL

OF THE

UNIVERSITY OF ILLINOIS

PRESENTED JUNE, 1907



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Donald S. Miller, B.S., 1906

ENTITLED Studies of the Artificial Digestion of Meat

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Master of Arts

APPROVED:

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H. S. Grindley

Instructor in Charge.

HEAD OF DEPARTMENT OF

Chemistry

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and to provide information for the purpose

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Experiments on digestion are of two kinds, natural and artificial. Both methods have been used for many years to determine the digestibility of food. The first experiments of course were by the natural method, and many devices were invented for watching the progress of digestion, and determining its results. Experimenting is still being done along this line for many purposes. Artificial digestion experiments were first contrived to take the place of natural digestion experiments. In the development of methods for this work however, many difficulties had to be overcome. Objections have been raised that the artificial digestion does not represent the same conditions as natural digestion, and therefore the results obtained by the two methods are not comparable. The differences in the two methods are summarized by Lea¹ as follows:-- In artificial digestion there is no motion of the contents, no continuous additions of fresh fluid and no removal of digestive products. Sailer and Farr² list the factors in natural digestion not found in artificial digestion as follows:--

1. Indigestion of food, water, and saliva.
2. Secretion of gastric juice.
3. Secretion of mucus.
4. Osmosis.
5. Discharge of contents through pylorus.

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to determine the effect of the different methods of treatment on the growth of the plants. The first experiment was

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6. Frequent regurgitation of the individual substance.

This however does not destroy the value of the artificial experiments. It has often been shown that the total digestibility by the two methods is about the same. The artificial method has a distinct advantageⁱⁿ the following ways. It is less cumbersome, it has fewer sources of experimental error, the method can be modified to suit a variety of purposes, and it is a convenient method of determining the rate of digestion.

The last two factors are of especial importance. If it is desired to determine the effect of different strengths of acid or pepsin solution, or to stop the fermentation before complete digestion for any purpose, it can be done much more easily than with natural digestion experiments. This point has been emphasized particularly by H. S. Grindley and T. Mojonnier, in their work in this laboratory, on the comparative digestibility of raw and cooked meats.

History of Artificial Digestion of Foods.

The history of artificial digestion really begins with the work of Stutzer.³ In 1880 he proposed a method which he thought would be of great value. He extracted the fat from a small sample of food, and digested the remainder for 24 hours in an acid pepsin solution. Then he filtered off the residue

1. Through regulation of the individual substance.

2. This means that the body must be able to regulate the rate of the reaction.

3. Experimental. It has often been shown that the actual digestibility

of the food actually is about the same. The actual rate is

not a constant although the following are. It is less

constant. It has lower values of experimental error, the actual

rate is affected to some extent of course, and it is a

constant in the case of determining the rate of reaction.

The last two points are of essential importance.

4. It is believed to determine the effect of different reactions

of food on the rate of reaction, or to give the formation of

products. It is believed to be constant, it can be done with some

accuracy and with animal digestion experiments. This point has

been mentioned previously by H. E. Gillingham and T. Johnston.

5. It is not a true law, but the experimental digestibility

of food is constant.

History of Animal Digestion of Food.

The history of animal digestion really begins

with the work of Storer. In 1880 he proposed a method which

is almost identical to that of the present. He measured the rate of

a small amount of food, and measured the temperature for 24 hours

and found the rate of reaction. Then he tried off the results.

and treated it with an alkaline solution of pancreatic extract. Finally he determined the N in the undissolved portion. Such treatment, he thought, represented approximately what took place in the stomach and duodenum.

Niebling⁴ modified this method by heating the contents of the flask to boiling for fifteen minutes after digestion with the acid pepsin for 24 hours, and neutralizing with Na_2CO_3 . Then the alkaline pancreatic solution was added without filtering and the digestion continued for 6 hours. The N in the residue was determined.

Wilson⁵ filtered off the residue from the pepsin digestion, and treated it for 12 hours with a pancreas solution made by dissolving 1 1/2 gm. Merck's pure pancreatin and 3 grams Na_2CO_3 in 1 l. of H_2O . The N in the residue was determined.

Pfeiffer⁶ compared natural with artificial digestion, and concluded that the treatment with the pancreatic solution in the latter method is unnecessary.

Köhne⁷ found that 48 hours was necessary for complete digestion by the acid pepsin.

Köhne, Bornstein, and Zietstorff⁸ obtained good results without removing the fat from the food before digestion.

Beaumont⁹ compared the rate of natural and artificial digestion, and found that the former required only from 1/4 to

and showed it with an equal or smaller amount of activity.

Results are shown in Table I in the unaltered position. Such

results in the case of the unaltered position are

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1/2 as much time for complete digestion as the latter.

Jessen⁰ was among the earliest to work upon the total digestibility of raw and cooked meats. His method is outlined as follows by Dr. H. S. Grindley and T. Mojonnier. Two hundred and fifty grams of beef were freed as completely as possible from sinew, fat, gristle, and bone; and similar portions of it were half boiled, well boiled, half roasted, and well roasted. The cooked meats were then partially dried; and a sample of each, and also of the raw meat, weighing 25 grams were treated with 400 c. c. of an acid pepsin solution containing in some cases 1 gram and in others two grams of pepsin per liter of either 0.1 or 0.2 per cent HCl. The digestion was continued for 24 hours, with frequent stirring, at a temperature of 37° C. The insoluble residue was then removed by filtration, dried at 100-110° C. for 2-5 hours, and weighed. From these weights, and the weights of the original samples, the proportions digested were computed.

He concluded that raw meat was more easily digested than cooked meat.

11

Chittenden and Cummins also worked on the relative ease of digestion of raw and cooked meats. Their results agree with those of Jessen.

12

Popoff¹² conducted experiments with both raw and cooked meats to see which digested the most easily. He digested each kind

Let us now turn to the results obtained in the latter.

Investigations were also conducted in each of the latter

investigations of the two most recent years. The results are outlined

in Table I. The results of the two most recent years are outlined

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of meat for periods of 3, 4, and 5 hours and arrested digestion by neutralizing with CaCO_3 . His results corroborated those of Jessen in regard to the digestibility of raw and cooked meats.

Stutzer,¹³ again in 1892, reported some results on artificial digestion. His problem, like that of some of the others, was to determine the relative digestibility of raw and cooked meats, and like them he concluded that raw meat was more easily digested.

In the digestion experiments so far, reported here, it is evident that these investigators worked for three things. 1. To devise a method of artificial digestion which would give results similar to natural digestion experiments. 2. To determine the total amount of food digested under certain conditions, and 3. (in some instances) to determine the relative digestibility of raw and cooked meats.

With the exception of Popoff and Stutzer, they did not give any information as to the rate of digestion; and none of them attempted to get much data concerning the effect of different methods of cooking upon the ease of digestion.

Experiments along this line have recently been conducted in this laboratory by H. S. Grindley and T. Mojonnier.¹⁴ They worked almost exclusively upon meat, and obtained a large number of results showing the relative ease of digestion of raw meat,

to meet the demand of 1, 2, 3, 4, and 5 hours and without disturbance
by withdrawing from 5000. The results indicated that it
was not possible to use the apparatus at the same time.

Experiments were made in 1905, repeated some results in

repeated experiments. The results, like that of some of the

others, was in favour of the relative insensitivity of the

and noted that, and the same is indicated that the same was

was not observed.

1. The position previously in 1905, repeated some

it is evident that some important points noted for some time.

4. To obtain a method of artificial digestion could make

give results similar to natural digestion as observed. 5.

To measure the total amount of food consumed under certain

conditions, and 6. The same method as observed in natural

digestibility of the same food.

1. The amount of food and water, and 2.

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and meat cooked in different ways. As it was necessary, in their work, to lay special stress upon the rate of digestion, the artificial method was far superior to the natural. The methods used by previous investigators, however, were not well adapted to the new line of work. A new method was then adopted which may be outlined as follows. The meat to be tested was ground thoroughly by passing three times through a sausage mill and mixed with the hands. It was then dried and powdered, and portions of from 0.8 to 1.2 gram were weighed out into 2 Jena beakers for digestion. (In later experiments this was modified by substituting a sample of from 2.00 to 2.5 grams of fresh meat for dried meat.) To the contents of each beaker were added 100 c. c. of an acid pepsin solution containing 2.5 grams of pepsin per liter of 0.33 per cent HCl solution (later the strength was changed to 1.25 gram to a liter of 0.33 per cent HCl solution). The beakers were then placed in a water bath, kept at 40° C., and digested for the required length of time. After digestion they were removed and filtered. (Another modification was made in later work by adding 10 c. c. of 40 per cent formalin to stop further digestion.) Filtering was accomplished by pouring the contents of the beakers into a funnel containing a corrugated hardened filter paper. The filtrate
 second filter
 from this filter was refiltered by passing through a fixed

in a similar way, just beneath the first one. The residues on the two filter papers were washed and the N determined by the Kjeldahl process. The per cent of nitrogen undigested could then be calculated by dividing the N in the residues by the total N in the original sample. To get the per cent digested this value was subtracted from 100.

Object of the Present Study.

It is the object of the experimental part of the present study to try to improve upon the method just outlined; so as to detect small differences in digestibility; and to shorten the operation sufficiently to make it useful for an extended series of experiments. The specific purpose for which a new method is desired is to determine the relative end of digestion of different kinds and different cuts of raw meat.

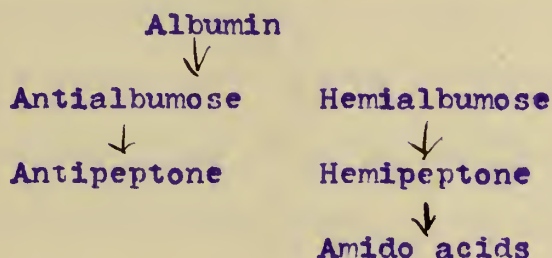
The Chemistry of Artificial Digestion.

At this point it seems advisable to outline briefly the action of the gastric juice, or the acid pepsin solution upon the proteids of flesh.

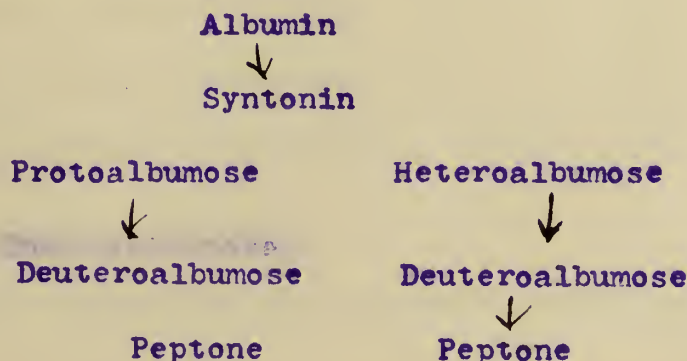
Flesh probably contains a large number of different proteid bodies. Each has its own characteristic properties,

but the action of pepsin solution is probably of the same nature on all of them. Pepsin itself is an unorganized ferment, secreted in acid solution by the mucus membrane of some animals, to produce fermentation of food. When the proteids of flesh come in contact with the pepsin in presence of HCl solution, a change is produced called proteolysis. "This¹⁵ consists in ^{the} breaking up of the very complex albumen molecule into smaller ones, the size and constitution of some of which are known." The products thus formed have been studied both qualitatively and quantitatively by numerous investigators. Plimmer¹⁶ outlines by diagram the theories of greatest moment.

Thus Kuhne thought the action went as follows.



Chittenden and Neumeister obtained results which may be represented thus.



Fränkel, Langstein, Salkowsky, and others have also worked upon the digestibility of different kinds of proteid bodies. Each separated compounds or groups of compounds at different stages in the digestive process and all agree pretty well as to the properties of the compounds formed. As a result we are safe in accepting the diagram of Chittenden as representing what takes place in the gastric digestion of meat.

This diagram of course does not represent all that takes place in gastric digestion. The action goes far beyond the peptone stage and gives numerous end products. A complete description of these end products is, as yet, impossible; but, from work done so far upon them, it seems that different proteid bodies give rise to different compounds. Thus 'Pfaundler¹⁷ obtained from serum albumin, leucine and a diamino acid, probably histidine, but from fibrin there was no leucine. He finds that the principle end products are apparently substances intermediate between peptone and amino acids. Langstein¹⁸ has obtained from crystallized egg albumin the following substances: leucine, tryosine, glutamic acid, asparatic acid, cystine, lysine, pentamethylemdiamine, hydroxyphenylethylamine, and a polymeric carbohydrate containing N, besides a few unidentified compounds.

Numerous methods for the quantitative separation

THESE THINGS ARE NOT TO BE TAKEN TOO SERIOUSLY

THEY ARE ONLY THE FIRST STEPS IN THE RIGHT DIRECTION

IT IS THE DUTY OF EVERY MAN TO DO HIS BEST

AND TO FOLLOW THE LEAD OF HIS BETTER ANGELS

AND TO REMEMBER THAT THE ONLY WAY TO SUCCESS IS BY THE WAY OF DUTY

AND TO REMEMBER THAT THE ONLY WAY TO KNOWLEDGE IS BY THE WAY OF EXPERIENCE

AND TO REMEMBER THAT THE ONLY WAY TO HAPPINESS IS BY THE WAY OF CONTENTMENT

AND TO REMEMBER THAT THE ONLY WAY TO PEACE IS BY THE WAY OF PATIENCE

AND TO REMEMBER THAT THE ONLY WAY TO TRUTH IS BY THE WAY OF SINCERITY

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of the first products of pepsin digestion have been worked out. They are based for the most part upon the insolubility of the compounds under different conditions. A study of the solubilities indicates the methods used for the separation.

Acid albumin is insoluble in a neutral solution, but very soluble in weak acid and alkali solutions. It precipitates from acid solution upon saturation with MgSO_4 and $(\text{NH}_4)_2\text{SO}_4$. Hawk and Geiss¹⁹ have demonstrated that acid albumin can be almost completely precipitated, after digestion with an acid, upon neutralization; and as albumose and peptones are not precipitated this is a method of separation. As the albumoses are precipitated by MgSO_4 and $(\text{NH}_4)_2\text{SO}_4$ the latter substances can not be used to separate acid albumins from albumoses.

"Albumoses are completely precipitated by the following alkaloidal reagents:-- phosphotungstic, phosphomolybdic, picric, tannic, trichlor-acetic, and metaphosphoric acids.²⁰ The best method of separating them from the peptones however, is by salting them out with $(\text{NH}_4)_2\text{SO}_4$ or MgSO_4 . Peptones do not precipitate with these salts.

Peptones are precipitated from neutral concentrated solutions by means of tannic acid and salt.²¹ The albumoses having been removed, this method can be used for the estimation of peptones.

Relative Quantities of Products Produced in Acid Pepsin Digestion.

The relative quantities of albumoses, peptones, and further end products of peptic digestion produced depend entirely upon the nature ^{of} proteid digested, strength of acid pepsin, and the time and temperature of digestion. Investigators seem to agree, however, that at no time during the action is the per cent of peptones very large. Allen²² (Commercial Organic Analysis, IV, p. 369) reports the following conclusion from the work of Chittenden. "Even with a large amount of active ferment, an abundance of free KCl, a proper temperature, and a long continued period of digestion (even five or six days), complete conversion into peptone never took place, the maximum yield being 60%. At that time it was supposed that the peptones were the final end products, and the conclusion therefore reached that the remainder of the digested material must consist of albumoses. This idea has since been proven erroneous, but the fact remains that the percentage of peptones produced is never very high.

Theory of the Chemical Action During Digestion.

Since a great many of the products of peptic digestion have been studied, a number of theories have been advanced regarding the kind of chemical change which takes place. It is

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generally agreed that proteolysis is the breaking up of a complex molecule into simpler ones. The method is supposed to be by hydrolysis. Chandelon²³ subjected albumin in solution to nascent H_2O_2 and obtained substances similar to the peptones. From this he concluded that the action was hydration. As to the manner of hydration he advanced two theories: First, that the digestive action produces H_2O_2 and this in turn causes hydration; second, that the chemical structure of the pepsin molecule is similar to that of H_2O_2 , namely $Pu - O - O - Pu$; and that this produces hydration directly. He thought the latter idea the better, but the evidence was not sufficient to be conclusive.

Effect of the Acid and the Pepsin in a Digesting Fluid, and the Most Effective Strengths of Acid Pepsin Solution.

Both the acid and the pepsin are important factors in the digestive action. Many investigators have experimented to determine just what part each played, and to show the effect of varying the quantity of each in a digestion fluid.

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"The part played by the HCl in peptic digestion is as yet but little understood." Goldschmidt and Lawrow maintain that HCl without pepsin will ultimately produce the same effect as if pepsin had been present; but this is probably not so.

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L. Harding states that a large part of the digestion action is due to HCl alone.

Allen²⁶ says when HCl is used alone the action goes so far as to form syntonin but not albumoses or peptones. When pepsin alone is used however, albumoses and peptones are produced as well as syntonin.

Dr. H. S. Grindley and T. Mojonier²⁷ (University Studies of U. of I., April, 1903. The Artificial Method for Determining the Ease and the Rapidity of the Digestion of Meats) working upon the digestibility of raw meat, have shown that a 0.33 per cent HCl solution digested about 23.0 per cent in twenty four hours; whereas, when the acid solution contained 1.25 gram of pepsin per liter the digestion amounted to 98 per cent.

Wm. Croner²⁸ reports experiments which show that the most efficient digestion fluid for albumin is an acid solution in which pepsin is more than 0.1 per cent and the HCl is between .05 and 0.1 per cent.

Muller²⁹ concludes that only in the case of low acidity, due to HCl being combined with the proteid, is pepsin digestion improved by increased free HCl; with higher original acidity, increase of free HCl has no effect.

Brucke³⁰ reports experiments on fibrin in which he tested the effect of changing the strength of HCl in a digestive fluid. In a solution containing 1.15 gram HCl per liter, it took 1/2 hour to digest a flake of fibrin; and every time the acidity

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WASHINGTON, D. C. 20315

MEMORANDUM FOR THE SECRETARY OF THE ARMY

SUBJECT: [REDACTED]

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was increased above this amount, the time of digestion increased. Therefore the most effective strength was 1.15 gram per liter or lower. In another experiment he showed that the most effective degree of acidity was between 0.40 and 0.80.

Mayer, Ad.³¹ (Zeit. f. Biol. 17, 351-60, 1881) shows that the time required for digestion depends upon the amount of pepsin used. He says, further, that when egg albumin is digested, the most effective strength of HCl is 0.02 per cent, provided the pepsin is kept constant (1 gm-l).

Iscovesco, Henri³² (Compt. Rend. Soc. Biol., 61, 282-84, 1906) quotes Mulder, Koopmans, and Brucke as saying that the most favorable degree of acidity in gastric juice varies according to the nature of the albumin digested. They showed also that a weak acidity favored digestion (From 0.07 per cent to 0.09 per cent solutions). His own experiments showed that with egg albumin and a 1 per cent pepsin solution an acid solution of 0.2 per cent was best. Roger and Garnier³³ (Compt. Rend. Soc. Biol., 61, 314-16) agree that an excess of HCl inhibits peptic digestion, but the optimum strength varies with the content of pepsin. They give reports from experiments showing the effect of varying both the acid and pepsin strength. A summary follows: When pepsin solution contains from ^{0.25}~~0.25~~ to 8 grams of pepsin a strength of ^{0.25}~~0.25~~ per cent HCl is most favorable. When a

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pepsin solution contains from 32 to 64 grams per liter ¹⁵ a strength of 0.5 per cent HCl is most favorable. When the pepsin solution rises to 128 grams to a liter, a strength of 0.1 per cent HCl is most favorable. When the acid is weak (0.031 per cent to 0.062 per cent) the best strength pepsin solution is 8 parts in 1000.

Gautier, Armond ³⁴ (Viry, Henri; De l'utilisation de la viande congelée l'alimentation du Soldat Lyons, 1898, p. 64) concluded, that, when the amount of pepsin is increased, the quantity of digested products also increases, although not proportionately; and that using constant absolute amounts of proteid, but decreasing the proteid concentration, the quantitative action increases, but not in proportion to the dilution of the proteid solution.

Use of Antiseptics in Artificial Digestion Experiment.

For many years it has been known that small quantities of certain substances have a marked inhibitory power on the digestive action. Among these substances are salicylic acid, benzoic acid, phenol, alcohol, alum, sodium hyposulphite, and formalin. The term antiseptics has been applied to them because they have power to prevent the growth of bacteria. For this reason some of them have been used commercially for the preservation of foods. As they not only prevent the growth of bacteria, but also destroy the power of unorganized ferments,

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such as pepsin and trypsin, their action has been studied in connection with the digestion of food during its progress through the alimentary canal.

Little use of these antiseptics was made in artificial digestion experiments, however, except to determine their harmfulness as a food adulterant, until Dr. Grindley and T. Mojonnier, in their work upon the rate of digestion of meat, adopted formalin as a means of stopping the action at different periods.³⁵ Their purpose was to find some means of controlling the digestion, which had not gone to completion, long enough to separate the digested from the undigested portion by filtration. In this way they determined the rate of digestibility by running different samples of the same kind of meat for different periods of time. After experimenting a short time to determine the most suitable quantity of the antiseptic to use in this work, they adopted the plan of adding 10 c. c. of 40 per cent formalin to the contents of the beakers, at the time they wished to retard the action. The success of the method is shown by numerous experiments.³⁶

Review of the Method of Artificial Digestion used by Grindley and Mojonnier; and brief study of its results.

It was said in the beginning that one object of the present study was to improve upon the method of artificial digestion,

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formerly used in this laboratory by Dr. Grindley and T. Mojonnier (University Studies of U. of I., April, 1903. The Artificial Method for Determining the Ease and the Rapidity of the Digestion of Meats) for the purpose of determining more accurately the rates of digestion of different meats, where only small differences existed. Let us, therefore, outline that method again and briefly study its results.

1st Step. Mix sample thoroughly by passing through sausage mill three times.

2nd Step. Weigh out samples of from two to 2 1/2 grams each into Jena beakers and add 100 c. c. of an acid pepsin solution of following strength, 1.25 grams pepsin to a liter of 0.33 per cent HCl.

3rd Step. Digest for required length of time at 40° C., stirring occasionally with a glass rod.

5th Step. Add 10 c. c. of 40 per cent formalin and remove from bath.

6th Step. Filter through two carefully prepared filters one above the other. Filter paper hardened and corrugated. Wash residue with hot H₂O.

7th Step. Transfer residues and the two filter papers to Kjeldahl flasks and determine the N by the Kjeldahl method.

This having been done, the per cent undigested was calculated by dividing the amount of N found in the residue

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by the amount of total N in the original sample of meat. By subtracting the per cent undigested from 100, the per cent digested was obtained.

The principle difficulties experienced in this process are these: 1. Filtration was extremely slow. In some cases it required two or three days to filter the 100 c. c. of the filtrate and wash the residues thoroughly. As a result of this slow filtration the tops of the lower filters had to be removed because it seemed that some of the soluble digestive products had crept up to the top of the paper, and resisted all efforts to wash them out. 2. The filtrates were always more or less turbid. This is accounted for by the fact that, by the method outlined, the acid albumins appear in the filtrate. Since the solution is acid after digestion, the acid albumins, or first products of proteolysis, are soluble; and the separation point between the undigested and digested portions is between the albumin and the acid albumin.

Only a few results from the many obtained by those who used this method are necessary at this point to show how reliable is the method. The following table is a portion of one made after an experiment on lean beef, round, raw, digested for one hour.³⁷

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Lab. No.	Coefficient of digestibility.
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1195a	64.27
-------	-------

1195b	60.51
-------	-------

1195c	63.24
-------	-------

1195d	79.66
-------	-------

1195e	63.62
-------	-------

1195f	71.65
-------	-------

Average-----66.69

It is evident that the figures for different portions of the same sample of meat in this table are quite variable. Whether this was due to either of the two difficulties mentioned in the preceding paragraph is not known, but the authors of the method thought that with more skill in manipulation, more uniform results could be obtained. Later work showed this to be the case, but the desired uniformity was seldom obtained in the digestion of raw meat.

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EXPERIMENTAL WORK.

Experiment 1.

The first experimental work done in the present study was to make a comparison of the rate of digestibility of poultry kept in cold storage for several months in an undrawn condition; and that which had been stored after being drawn. The object was two fold, first to make the comparison just mentioned; and second, to test the effectiveness of a slight change in the kind of filters used.

Preparation of Samples. The meat was cut as completely as possible from six undrawn chickens which were in a frozen condition. When all the bone and gristle had been separated from the flesh, the latter was thoroughly nixed by passing it three times through a sausage mill. A small representative portion was then packed in a mason jar and labelled 2111. Half a dozen drawn chickens were then sampled in the same way and labelled 2112.

Method. The method used in this experiment was the same as that outlined on page 17 except for a modification in the kind of filters and in the strength of acid pepsin solution. Instead

of using hardened quantitative paper in both the upper and lower funnels it was placed only in the lower one. The upper funnel was fitted with an ordinary quantitative filter paper and in this was placed a little cotton. Cotton also was pressed into the short stem of this funnel. It was thought such an arrangement might hasten the filtration and produce a filtrate as clear as by the old method. The acid pepsin solution contained 1 gram of pepsin (MERCK) to a liter of N/10 HCl.

Sixteen samples of meat from each jar were weighed out and digested. The first part of the experiment (a) was made upon the undrawn, and the second (b) upon the drawn chicken. In each case four samples were digested for 1 hour (Nos. 2111/1 to 2111/4 and 2112/1 to 2112/4 inclusive); four for 2 hours (Nos. 2111/5 to 2111/8 and 2112/5 to 2112/8 inclusive); four for six hours (Nos. 2111/9 to 2111/12 and 2112/9 to 2112/12 inclusive); and four for 12 hours (Nos. 2111/12 to 2111/16 and 2112/13 to 2112/16 inclusive). The results are given in table 1.

Observations and conclusions. From the results there given it seems that the meat from the undrawn poultry digested a little more rapidly than that from the drawn poultry. At the end of the first hour the difference was about 2 per cent, at the end of the second hour, 4 per cent, at the end of the

Table 1.

Rate of digestion of drawn and undrawn poultry.

Experiment 1.

Exp. No.	Lab. No.	Kind of meat.	Time of digestion.	Per cent of digested N.
1a	2111/1	Chicken, undrawn, frozen	1 hr.	84.20
"	2111/2	" " "	1 "	-----
"	2111/3	" " "	1 "	89.49#
"	2111/4	" " "	1 "	83.87
Average-----				84.04
"	2111/5	" " "	2 "	-----
"	2111/6	" " "	2 "	72.37
"	2111/7	" " "	2 "	88.29
"	2111/8	" " "	2 "	87.71
Average-----				82.79
"	2111/9	" " "	6 "	98.77
"	2111/10	" " "	6 "	-----
"	2111/11	" " "	6 "	91.21
"	2111/12	" " "	6 "	-----
Average-----				94.99
"	2111/13	" " "	12 "	94.01
"	2111/14	" " "	12 "	-----
"	2111/15	" " "	12 "	-----
"	2111/16	" " "	12 "	93.28
Average-----				93.65
1b	2112/1	" drawn "	1 "	81.59
"	2112/2	" " "	1 "	-----
"	2112/3	" " "	1 "	83.08
"	2113/4	" " "	1 "	81.26
Average-----				81.97

This number is not included in the numbers averaged.

Table 1.

23

Rate of digestion of drawn and undrawn poultry.

Experiment 1.

Exp. No.	Lab. No.	Kind of meat.	Time of digestion.	Per cent of digested N.
1b	2112/5	Chicken, drawn, frozen	2 hrs.	79.23
"	2112/6	" " "	2 "	94.33#
"	2112/7	" " "	2 "	80.54
"	2112/8	" " "	2 "	76.09
Average-----				78.62
"	2112/9	" " "	6 "	92.54
"	2112/10	" " "	6 "	-----
"	2112/11	" " "	6 "	92.90
"	2112/12	" " "	6 "	-----
Average-----				92.67
"	2112/13	" " "	12 "	-----
"	2112/14	" " "	12 "	93.22
"	2112/15	" " "	12 "	94.62
"	2112/16	" " "	12 "	89.74
Average-----				92.53

This number is not included in the numbers averaged.

Table 1.
Rate of electricity of power and underground double.
Expenditure 1.

Exp. No.	Exp. No.	Kind of work.	Time of work.	Rate of electricity of power and underground double.
1	2	3	4	5
10	11	12	13	14
15	16	17	18	19
20	21	22	23	24
25	26	27	28	29
30	31	32	33	34
35	36	37	38	39
40	41	42	43	44
45	46	47	48	49
50	51	52	53	54
55	56	57	58	59
60	61	62	63	64
65	66	67	68	69
70	71	72	73	74
75	76	77	78	79
80	81	82	83	84
85	86	87	88	89
90	91	92	93	94
95	96	97	98	99
100	101	102	103	104

The figures in the column to the right of the table are the same as in the table.

sixth hour, 2 per cent, and at the end of the 12th hour, 1 per cent. There was no digestive action between the sixth and twelfth hours. Presumably therefore the digestion was completed at the end of the former period.

It is not intended however to draw conclusions of this kind from this experiment. It is evident that the variations in the duplicates are in some cases as much as the differences between the drawn and undrawn poultry. Furthermore a sufficient number of results were not obtained to give any reliable information as to the relative rates of digestion. The experiment was disappointing from a mechanical standpoint because the change in the filters did not prove successful in hastening filtration. It was entirely too slow to be practicable, and the filtrates were all turbid. Another difficulty was experienced in Kjeldahling the residues. The large amount of cellulose due to the cotton and two filter papers caused trouble.

Experiment 2.

After the first experiment attempts were made to contrive some arrangement by which the difficulties in filtration could be overcome. None was successful however and in the second experiment the same method was used as in experiment 1, except that the cotton was discarded.

APPROXIMATE PERCENTAGE OF POPULATION IN EACH CATEGORY BY REGION

on the following two points. The first point is that the

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Object. The object of experiment 2 was to determine two things: first the effect of varying the strength of the digestive fluid; and second the relative value of formalin and phenol as an antiseptic. The purpose of changing the strength of acid was to retard the action and thus show wider differences in the amount digested after each interval of time. The use of a new antiseptic was not necessary, since formalin had been found satisfactory but, as phenol had been suggested it was tried.

Method. Thirty two samples of beef (round, lean) were used in this experiment. They were all taken from the sample labelled 2120. The experiment was divided into four parts a, b, c, and d. Section a included laboratory numbers 2120/1 to 2120/8, section b numbers 2120/17 to 2120/24, section c numbers 2120/41 to 2120/48, and section d numbers 2120/49 to 2120/56. Section a was conducted as follows. Four samples were weighed out in the usual manner and treated with 100 c. c. of acid pepsin solution containing 1 gram of pepsin to 1 liter of N/10 HCl. They were digested for one hour, treated with formalin and filtered as quickly as possible. Four more samples were treated with the same strength acid pepsin solution, digested for 2 hours, treated with formalin and filtered as before. In section b also, eight samples were used.

Four of them were treated with 100 c. c. of an acid pepsin solution containing $1/2$ gram of pepsin to a liter of N/50 HCl. They were digested for one hour, treated with formalin and filtered immediately. The other four were treated in the same manner but were digested two hours instead of one. Section c was conducted the same as section a except that phenol was used in place of formalin. Section d was carried on in a little different way. Four of the samples were treated as the first four of c but instead of the contents of the beakers being filtered immediately after the phenol was added, they were allowed to stand for 24 hours before filtering. The other four samples were treated as the second four in a but here also the filtration was not begun until 70 hours after formalin had been added. The results of this operation are shown in table 2.

Observations and Conclusions. It is evident from the results of a and b that there was a decrease in the digestibility at the end of the first hour, when the acid pepsin solution was weakened, of about 10%. At the end of the second hour an increase in digestibility appeared but as only one out of four results was obtained it can not be relied upon. Although the results here given are too few to warrant us in drawing any general conclusions concerning the effect of different strengths of the digestive fluid, they indicate that the weaker of the two solutions used

CHANGES OF TEMPERATURE AND HUMIDITY DURING THE COURSE OF THE EXPERIMENT.

Experiment 2.

Exp. No.	Temp. of Air, °C.	Temp. of Soil, °C.	Humidity, %	Time of Day	Remarks
1	18.5	15.0	65	8.00	Start of experiment.
2	19.0	15.5	68	8.30	
3	19.5	16.0	70	9.00	
4	20.0	16.5	72	9.30	
5	20.5	17.0	75	10.00	
6	21.0	17.5	78	10.30	
7	21.5	18.0	80	11.00	
8	22.0	18.5	82	11.30	
9	22.5	19.0	85	12.00	
10	23.0	19.5	88	12.30	
11	23.5	20.0	90	13.00	
12	24.0	20.5	92	13.30	
13	24.5	21.0	95	14.00	
14	25.0	21.5	98	14.30	
15	25.5	22.0	100	15.00	
16	26.0	22.5	100	15.30	
17	26.5	23.0	100	16.00	
18	27.0	23.5	100	16.30	
19	27.5	24.0	100	17.00	
20	28.0	24.5	100	17.30	
21	28.5	25.0	100	18.00	
22	29.0	25.5	100	18.30	
23	29.5	26.0	100	19.00	
24	30.0	26.5	100	19.30	
25	30.5	27.0	100	20.00	
26	31.0	27.5	100	20.30	
27	31.5	28.0	100	21.00	
28	32.0	28.5	100	21.30	
29	32.5	29.0	100	22.00	
30	33.0	29.5	100	22.30	
31	33.5	30.0	100	23.00	
32	34.0	30.5	100	23.30	
33	34.5	31.0	100	24.00	
34	35.0	31.5	100	24.30	
35	35.5	32.0	100	25.00	
36	36.0	32.5	100	25.30	
37	36.5	33.0	100	26.00	
38	37.0	33.5	100	26.30	
39	37.5	34.0	100	27.00	
40	38.0	34.5	100	27.30	
41	38.5	35.0	100	28.00	
42	39.0	35.5	100	28.30	
43	39.5	36.0	100	29.00	
44	40.0	36.5	100	29.30	
45	40.5	37.0	100	30.00	
46	41.0	37.5	100	30.30	
47	41.5	38.0	100	31.00	
48	42.0	38.5	100	31.30	
49	42.5	39.0	100	32.00	
50	43.0	39.5	100	32.30	
51	43.5	40.0	100	33.00	
52	44.0	40.5	100	33.30	
53	44.5	41.0	100	34.00	
54	45.0	41.5	100	34.30	
55	45.5	42.0	100	35.00	
56	46.0	42.5	100	35.30	
57	46.5	43.0	100	36.00	
58	47.0	43.5	100	36.30	
59	47.5	44.0	100	37.00	
60	48.0	44.5	100	37.30	
61	48.5	45.0	100	38.00	
62	49.0	45.5	100	38.30	
63	49.5	46.0	100	39.00	
64	50.0	46.5	100	39.30	
65	50.5	47.0	100	40.00	
66	51.0	47.5	100	40.30	
67	51.5	48.0	100	41.00	
68	52.0	48.5	100	41.30	
69	52.5	49.0	100	42.00	
70	53.0	49.5	100	42.30	
71	53.5	50.0	100	43.00	
72	54.0	50.5	100	43.30	
73	54.5	51.0	100	44.00	
74	55.0	51.5	100	44.30	
75	55.5	52.0	100	45.00	
76	56.0	52.5	100	45.30	
77	56.5	53.0	100	46.00	
78	57.0	53.5	100	46.30	
79	57.5	54.0	100	47.00	
80	58.0	54.5	100	47.30	
81	58.5	55.0	100	48.00	
82	59.0	55.5	100	48.30	
83	59.5	56.0	100	49.00	
84	60.0	56.5	100	49.30	
85	60.5	57.0	100	50.00	
86	61.0	57.5	100	50.30	
87	61.5	58.0	100	51.00	
88	62.0	58.5	100	51.30	
89	62.5	59.0	100	52.00	
90	63.0	59.5	100	52.30	
91	63.5	60.0	100	53.00	
92	64.0	60.5	100	53.30	
93	64.5	61.0	100	54.00	
94	65.0	61.5	100	54.30	
95	65.5	62.0	100	55.00	
96	66.0	62.5	100	55.30	
97	66.5	63.0	100	56.00	
98	67.0	63.5	100	56.30	
99	67.5	64.0	100	57.00	
100	68.0	64.5	100	57.30	

Table 2.

Change of strength of acid pepsin solution and comparison of formalin and phenol as antiseptics.

Experiment 2.

Exp. No.	Lab. No.	Strength of Acid. Pepsin.		Time of digestion.	Antiseptic used.	Time of standing before filtering.	Per cent of digested nitrogen.
2c	2120/45	N/10	1 gm-1	2 hrs.	Phenol	None	81.52
"	2120/46	"	"	2 "	"	"	99.46#
"	2120/47	"	"	2 "	"	"	78.35
"	2120/48	"	"	2 "	"	"	-----
Average-----							79.93
2d	2120/49	"	"	1 hr.	"	24 hrs.	73.80
"	2120/50	"	"	1 "	"	24 "	73.40
"	2120/51	"	"	1 "	"	24 "	76.59
"	2120/52	"	"	1 "	"	24 "	75.99
Average-----							74.94
"	2120/53	"	"	2 hrs.	Formalin	70 "	95.56
"	2120/54	"	"	" "	"	70 "	-----
"	2120/55	"	"	" "	"	70 "	95.62
"	2120/56	"	"	" "	"	70 "	95.09
Average-----							95.42

This number is not included in the numbers averaged.

On the basis of the above information, it is recommended that the proposed project be approved for funding.

Exp. No.	Time of Analysis	Time of Analysis	Time of Analysis	Time of Analysis	Time of Analysis	Time of Analysis	Time of Analysis
52	11:00/11:10	11:10/11:20	11:20/11:30	11:30/11:40	11:40/11:50	11:50/12:00	12:00/12:10
53	11:10/11:20	11:20/11:30	11:30/11:40	11:40/11:50	11:50/12:00	12:00/12:10	12:10/12:20
54	11:20/11:30	11:30/11:40	11:40/11:50	11:50/12:00	12:00/12:10	12:10/12:20	12:20/12:30
55	11:30/11:40	11:40/11:50	11:50/12:00	12:00/12:10	12:10/12:20	12:20/12:30	12:30/12:40
56	11:40/11:50	11:50/12:00	12:00/12:10	12:10/12:20	12:20/12:30	12:30/12:40	12:40/12:50
57	11:50/12:00	12:00/12:10	12:10/12:20	12:20/12:30	12:30/12:40	12:40/12:50	12:50/1:00
58	12:00/12:10	12:10/12:20	12:20/12:30	12:30/12:40	12:40/12:50	12:50/1:00	1:00/1:10
59	12:10/12:20	12:20/12:30	12:30/12:40	12:40/12:50	12:50/1:00	1:00/1:10	1:10/1:20
60	12:20/12:30	12:30/12:40	12:40/12:50	12:50/1:00	1:00/1:10	1:10/1:20	1:20/1:30
61	12:30/12:40	12:40/12:50	12:50/1:00	1:00/1:10	1:10/1:20	1:20/1:30	1:30/1:40
62	12:40/12:50	12:50/1:00	1:00/1:10	1:10/1:20	1:20/1:30	1:30/1:40	1:40/1:50
63	12:50/1:00	1:00/1:10	1:10/1:20	1:20/1:30	1:30/1:40	1:40/1:50	1:50/2:00
64	1:00/1:10	1:10/1:20	1:20/1:30	1:30/1:40	1:40/1:50	1:50/2:00	2:00/2:10
65	1:10/1:20	1:20/1:30	1:30/1:40	1:40/1:50	1:50/2:00	2:00/2:10	2:10/2:20
66	1:20/1:30	1:30/1:40	1:40/1:50	1:50/2:00	2:00/2:10	2:10/2:20	2:20/2:30
67	1:30/1:40	1:40/1:50	1:50/2:00	2:00/2:10	2:10/2:20	2:20/2:30	2:30/2:40
68	1:40/1:50	1:50/2:00	2:00/2:10	2:10/2:20	2:20/2:30	2:30/2:40	2:40/2:50
69	1:50/2:00	2:00/2:10	2:10/2:20	2:20/2:30	2:30/2:40	2:40/2:50	2:50/3:00
70	2:00/2:10	2:10/2:20	2:20/2:30	2:30/2:40	2:40/2:50	2:50/3:00	3:00/3:10

has a tendency to retard the action for the first hour.

As to the comparative value of formalin and phenol as an antiseptic, sections a and c show there is little difference. In one hour with formalin an average of 76.69 per cent was digested and with phenol 73.87. In two hours with formalin 80.93 was digested and with phenol 79.93. Furthermore in d it is shown that when phenol was used and the solutions allowed to stand 24 hours before filtering the amount digested averaged 74.94. This indicates that the phenol had been effective in completely stopping the action at the end of the second hour. When formalin was used and the solutions allowed to stand 70 hours before filtration the results show that digestion must have continued after the formalin was added. It has formerly been shown however, that formalin is perfectly satisfactory in preventing the action for twenty four hours. During the progress of the experiment it was noticed that a light precipitate seemed to form in the solution upon the addition of phenol. The latter substance, moreover, seemed a little more troublesome during the mechanical manipulations than formalin and for these reasons it was not used in later experiments.

The results of experiment 2, like those of experiment 1, are somewhat disappointing because the duplicates in many cases do not check. Until this feature is corrected it is impossible.

that a number of persons had been for some time

at the residence of the late Mr. Thomas

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in the year 1840, and it was found that

and was one of the most interesting

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to draw conclusions from the figures. In this experiment also the same difficulties in filtering as before were experienced.

Experiment 3.

Since the method used in the previous experiments had proven impracticable because of the difficulty in filtering, and the inaccuracies in results, some change was desired to eliminate these difficulties.

No progress was made toward a remedy however, until it was suggested, by Dr. Grindley, that the solution be neutralized before filtration. This, he thought might hasten filtration, and also would represent more nearly the conditions actually existing in natural digestion. Furthermore a study of the methods of artificial digestion of the earlier investigators shows that in nearly all cases they separated the undigested portions after neutralization. Such a process is a radical departure from the method used previously in the first two experiments of this study. It will be remembered that during the progress of digestion some of the albumin is converted into syntonium (acid albumin), albumose, and peptone, as well as to further end products. When the solution is filtered without neutralization, as has been described the insoluble albumin

no other conditions from the present. It was evident

that the only way to proceed is to make sure

CHAPTER 2.

The first thing that is the obvious conclusion

from the above is that the activity is

and the first thing to be done is to make

slightly different.

As a result, we have a new

it is necessary to be able to

before the first. The first thing to be

and then we have a new

which is the first thing to be

the first thing to be done is to make

shown that it is not a

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is separated from the acid albumins, albumoses, and peptones. The albumoses and peptones being very soluble filter rapidly but the acid albumins being of much greater molecular weight cause the pores of the filter to become clogged and inhibit filtration. Furthermore they cause turbidity of the filtrate. But if the solutions were neutralized before filtration different conditions would exist. The acid of the acid albumin being neutralized, the proteid would precipitate and become insoluble in the neutral solution. The albumoses and peptones would filter through as before and the separation point instead of being between the albumin and acid albumin would be between the albumin and albumose. Theoretically the neutralization should materially hasten filtration and eliminate the turbidity of the filtrate. The objection might be raised at this point of course that neutralization would destroy the value of the experiments since it would not parallel the conditions existing in the stomach. There is no reason however for saying that without neutralization the conditions in the stomach are more nearly obtained than with neutralization. In no case can the conditions in artificial experiments be made exactly parallel to those of the alimentary tract, so the best method which approximates these conditions is most valuable. The term digestion is vague and indefinite, and there is no reason

why the neutralization method should not be called digestion as well as the other. In this connection Allen says:³⁸ "There has commonly been no marked distinction drawn between the mere conversion of albumin into syntonin or other soluble forms and the true peptonization characteristic of the action of pepsin, both these changes having been confounded under the term digestion." In this experiment therefore the solutions were neutralized after digestion as described below.

Object. The object of experiment 3 was to compare the results of the neutralization method with those formerly obtained, and the effect of HCl alone and the acid pepsin solution.

Method. Ten samples of lean beef (round) were weighed out as usual and labelled from 2120/81 to 2120/90 inclusive. The first five were treated with 100 c. c. of N/10 HCl but no pepsin. Number 2120/81 was digested for 1 hour, number 2120/12 for 2 hours, 2120/83 for 6 hours, 2120/84 for 12 hours, and 2120/85 for 24 hours. At the end of digestion 10 c. c. of formalin were added to each and the solutions neutralized with KOH to litmus paper. Normal KOH was added until the solution was nearly neutralized and then the operation was completed with a N/50 KOH solution. After being neutralized the contents of the beakers were filtered. The remaining five samples were treated with 100 c. c. of an acid pepsin solution containing 1 gram of pepsin per liter of N/10 HCl. They were

for the investigation of the effect of the concentration of the solution on the rate of reaction. The rate of reaction was determined by measuring the amount of gas evolved at intervals of time. The results are given in Table I.

For the purpose of comparison, the rate of reaction was also determined for the reaction of the same solution with a known amount of the same substance. The results are given in Table II.

Method. The reaction was carried out in a glass vessel of known volume. The gas evolved was collected over water in a graduated gasometer. The rate of reaction was determined by measuring the volume of gas evolved at intervals of time. The results are given in Table I.

The concentration of the solution was determined by titration with a standard solution of sodium hydroxide. The results are given in Table III.

At the end of the reaction, the solution was cooled to room temperature. The gas evolved was collected over water in a graduated gasometer. The rate of reaction was determined by measuring the volume of gas evolved at intervals of time. The results are given in Table I.

The concentration of the solution was determined by titration with a standard solution of sodium hydroxide. The results are given in Table III.

Comparison of acid alone and acid pepsin solution as digestive fluid.

Experiment 3.

Exp. No.	Lab. No.	Strength of Acid. Pepsin.		Antiseptic used.	Time of digestion.	Per cent of nitrogen digested.
3	2120/81	N/10	None	Formalin	1 hr.	14.15
"	2120/82	"	"	"	2 "	-----
"	2120/83	"	"	"	6 "	20.49
"	2120/84	"	"	"	12 "	14.12
"	2120/85	"	"	"	24 "	13.02
"	2120/86	"	1 gm-l	"	1 "	79.38
"	2120/87	"	"	"	2 "	87.06
"	2120/88	"	"	"	6 "	92.10
"	2120/89	"	"	"	12 "	94.32
"	2120/90	"	"	"	24 "	95.58

Comparison of the results of the two methods of determining the concentration of the solution

Table 1

Conc. of solution, %	Conc. of solution, %	Conc. of solution, %	Conc. of solution, %	Conc. of solution, %	Conc. of solution, %
0.1	0.1	0.1	0.1	0.1	0.1
0.2	0.2	0.2	0.2	0.2	0.2
0.3	0.3	0.3	0.3	0.3	0.3
0.4	0.4	0.4	0.4	0.4	0.4
0.5	0.5	0.5	0.5	0.5	0.5
0.6	0.6	0.6	0.6	0.6	0.6
0.7	0.7	0.7	0.7	0.7	0.7
0.8	0.8	0.8	0.8	0.8	0.8
0.9	0.9	0.9	0.9	0.9	0.9
1.0	1.0	1.0	1.0	1.0	1.0
1.1	1.1	1.1	1.1	1.1	1.1
1.2	1.2	1.2	1.2	1.2	1.2
1.3	1.3	1.3	1.3	1.3	1.3
1.4	1.4	1.4	1.4	1.4	1.4
1.5	1.5	1.5	1.5	1.5	1.5
1.6	1.6	1.6	1.6	1.6	1.6
1.7	1.7	1.7	1.7	1.7	1.7
1.8	1.8	1.8	1.8	1.8	1.8
1.9	1.9	1.9	1.9	1.9	1.9
2.0	2.0	2.0	2.0	2.0	2.0

digested as follows:-- No. 2120/86 for 1 hour, 2120/87 for 2 hours, 2120/88 for 6 hours, 2120/89 for 12 hours, and 2120/90 for 24 hours. These also were neutralized after the addition of formalin and then filtered. It was found upon filtering, that the double filter was not necessary ^{in order} to make the filtrate almost clear, so only one funnel, containing a quantitative filter paper, was used. With the exception of the modifications here mentioned the method was the same as in the previous experiment.

Observations and Conclusions. From the table it is evident that the HCl alone digested only a small amount in one hour and that this except in one case, was not increased by longer digestion. As no duplicates were run in this experiment, the results cannot be depended on, but the similarity of the digested portion for the 1, 12, and 24 hour periods indicates that the digestion does not increase. An explanation of this can easily be made. HCl acts upon albumin and produces acid albumin, but the action goes no further. Then the solution is neutralized and the albumin is again precipitated.

The results with the acid pepsin solution show that digestion progresses from approximately 80% in one hour to 95% in 24 hours. The results are similar to those obtained in experiments 1 and 2a. They show therefore two things: first, that the new method in which neutralization is accomplished gives

a coefficient of digestibility as high as without neutralization and, second that the pepsin added to the acid solution increases the digestibility from about 14% in one hour to approximately 80%. If the first of these conclusions is true it is also evident that with acid pepsin solution, the quantity of acid albumin present at any time is small. Otherwise, upon neutralization, there would be a material decrease in the amount digested and an increase in the amount undigested.

Considerable encouragement was drawn from this experiment on account of the rapidity of filtration. Since the acid albumin was precipitated by neutralization, the solutions filtered quite rapidly. At the same time the filtrates were not very turbid and it was thought with more perfect neutralization they could be made entirely clear. On the whole, therefore, it was considered a great improvement to neutralize the solutions after digestion.

Experiment 4.

Since a method had been obtained which seemed to be fairly satisfactory as regards accuracy and quite acceptable as regards speed, an extensive experiment was planned.

Object. The object of experiment 4 was to determine the differences in the rate of digestibility of the wholesale

cuts of beef.

Method. A prime steer, 2 years old had been slaughtered for analytical purposes and one half of the animal divided into wholesale cuts. A representative sample from each of 9 of the cuts was taken for digestion work. The cuts and their laboratory numbers were as follows: Round No. 2134, loin No. 2136, rib No. 2137, flank No. 2138, plate No. 2139, Chuck No. 2140, clod No. 2141, neck No. 2142, fore shank No. 2143. Samples of from two to 2.5 grams of meat from each cut were taken and treated with an acid pepsin solution containing 1 gram of pepsin per liter of 0.2 per cent HCl. It was planned to digest three samples from each cut for 1 hour, three for two hours, three for four hours, and three for 12 hours. In some cases, however, the 2 hour, 4 hour, and 12 hour periods were omitted as the table shows. In every case the samples digested for 1 hour were numbered from 1 to 3 inclusive, the two hour samples from 4 to 6 inclusive, the 4 hour samples from 7 to 9 inclusive, and the 12 hour samples from 10 to 12 inclusive. For instance the samples of the loin digested for one hour included 2136/1 and 2136/3, for two hours 2136/4 and 2136/6, for 4 hours 2136/7 and 2136/9, and for 12 hours 2136/10 and 2136/12. The manipulation was the same as in experiment 3, except that neutralization of the digested solution was more carefully done. This

was accomplished by heating the beakers on the water bath at 90° and neutralizing them while hot. The KOH solution was added from a pipette drop by drop until the solution was neutral to litmus^{paper}. In most cases, after neutralization the precipitated and insoluble proteids coagulated leaving a clear liquid instead of a turbid one as had been obtained without heating on the water bath. Another slight change in the method was the elimination of the formalin. It was not used because it was thought the neutralization would prevent all action of the HCl and heating to 90° would destroy the power of the pepsin. After the contents of the beakers had been heated for about 1/2 hour, they were filtered through a single quantitative filter paper while hot. Filtration was rapid. In a great many cases the filtrates were not quite clear and some of these were refiltered. The remainder of the processes^{was} carried on were the same as before, and the results of the experiment are shown in table 4.

Observations and Conclusions. A study of the table shows some very peculiar results. The round for example was much more easily digestible than the loin because it took four hours to digest as much of the latter as was digested in one hour by the former. The rib digested at about the same rate as the round and the flank was midway between that and the loin.

Table 4.

Ratio of digestion of different wholesale cuts of beef.

Experiment 4.

Exp. No.	Lab. No.	Wholesale cut.	Strength of Acid. Pepsin.		Time of digestion.	Per cent of digested nitrogen.
			Per cent.			
4	2134/1	Round	0.2	1 gm-1	1 hr.	87.75
"	2134/2	"	"	"	1 "	88.93
"	2134/3	"	"	"	1 "	89.63
Average-----						88.77
"	2134/4	"	"	"	2 hrs.	91.20
"	2134/5	"	"	"	2 "	90.66
"	2134/6	"	"	"	2 "	92.85
Average-----						91.57
"	2134/7	"	"	"	4 "	91.94
"	2134/8	"	"	"	4 "	92.96
"	2134/9	"	"	"	4 "	93.76
Average-----						92.88
"	2136/1	Loin	"	"	1 hr.	62.81
"	2136/2	"	"	"	1 "	68.88
"	2136/3	"	"	"	1 "	-----
Average-----						65.84
"	2136/4	"	"	"	2 hrs.	64.97
"	2136/5	"	"	"	2 "	65.28
"	2136/6	"	"	"	2 "	67.29
Average-----						65.84
"	2136/7	"	"	"	4 "	-----
"	2136/8	"	"	"	4 "	89.91
"	2136/9	"	"	"	4 "	-----
Average-----						89.91

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Table 4.

Ratio of digestion of different wholesale cuts of beef.

Experiment 4.

Exp. No.	Lab. No.	Wholesale cut.	Strength of Acid. Pepsin. Per cent.		Time of digestion.	Per cent of digested nitrogen.
4	2136/10	Loin	0.2	1 gm-1	12 hrs.	88.97
"	2136/11	"	"	"	12 "	91.13
"	2136/12	"	"	"	12 "	77.53#
Average-----						90.05
"	2137/1	Rib	"	"	1 hr.	87.85
"	2137/2	"	"	"	1 "	88.09
"	2137/3	"	"	"	1 "	-----
Average-----						87.97
"	2137/4	"	"	"	2 "	89.58
"	2137/5	"	"	"	2 "	88.13
"	2137/6	"	"	"	2 "	87.75
Average-----						88.48
"	2137/7	"	"	"	4 "	90.02
"	2137/8	"	"	"	4 "	89.40
"	2137/9	"	"	"	4 "	90.37
Average-----						89.93
"	2138/1	Flank	"	"	1 "	79.67
"	2138/2	"	"	"	1 "	66.96
"	2138/3	"	"	"	1 "	82.40
Average-----						81.03
"	2138/4	"	"	"	2 "	85.56
"	2138/5	"	"	"	2 "	83.19
"	2138/6	"	"	"	2 "	82.95
Average-----						83.90
"	2138/7	"	"	"	4 "	-----
"	2138/8	"	"	"	4 "	90.70
"	2138/9	"	"	"	4 "	90.88
Average-----						90.79

This number is not included in the numbers averaged.

Analysis of different waterways for acid.

Experiment 1.

Exp. No.	Lab. No.	Sample No.	Acid. Type	Strength of Acid. Type	Time of Boiling	Weight of Boiling
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9
10	10	10	10	10	10	10
11	11	11	11	11	11	11
12	12	12	12	12	12	12
13	13	13	13	13	13	13
14	14	14	14	14	14	14
15	15	15	15	15	15	15
16	16	16	16	16	16	16
17	17	17	17	17	17	17
18	18	18	18	18	18	18
19	19	19	19	19	19	19
20	20	20	20	20	20	20
21	21	21	21	21	21	21
22	22	22	22	22	22	22
23	23	23	23	23	23	23
24	24	24	24	24	24	24
25	25	25	25	25	25	25
26	26	26	26	26	26	26
27	27	27	27	27	27	27
28	28	28	28	28	28	28
29	29	29	29	29	29	29
30	30	30	30	30	30	30
31	31	31	31	31	31	31
32	32	32	32	32	32	32
33	33	33	33	33	33	33
34	34	34	34	34	34	34
35	35	35	35	35	35	35
36	36	36	36	36	36	36
37	37	37	37	37	37	37
38	38	38	38	38	38	38
39	39	39	39	39	39	39
40	40	40	40	40	40	40
41	41	41	41	41	41	41
42	42	42	42	42	42	42
43	43	43	43	43	43	43
44	44	44	44	44	44	44
45	45	45	45	45	45	45
46	46	46	46	46	46	46
47	47	47	47	47	47	47
48	48	48	48	48	48	48
49	49	49	49	49	49	49
50	50	50	50	50	50	50
51	51	51	51	51	51	51
52	52	52	52	52	52	52
53	53	53	53	53	53	53
54	54	54	54	54	54	54
55	55	55	55	55	55	55
56	56	56	56	56	56	56
57	57	57	57	57	57	57
58	58	58	58	58	58	58
59	59	59	59	59	59	59
60	60	60	60	60	60	60
61	61	61	61	61	61	61
62	62	62	62	62	62	62
63	63	63	63	63	63	63
64	64	64	64	64	64	64
65	65	65	65	65	65	65
66	66	66	66	66	66	66
67	67	67	67	67	67	67
68	68	68	68	68	68	68
69	69	69	69	69	69	69
70	70	70	70	70	70	70
71	71	71	71	71	71	71
72	72	72	72	72	72	72
73	73	73	73	73	73	73
74	74	74	74	74	74	74
75	75	75	75	75	75	75
76	76	76	76	76	76	76
77	77	77	77	77	77	77
78	78	78	78	78	78	78
79	79	79	79	79	79	79
80	80	80	80	80	80	80
81	81	81	81	81	81	81
82	82	82	82	82	82	82
83	83	83	83	83	83	83
84	84	84	84	84	84	84
85	85	85	85	85	85	85
86	86	86	86	86	86	86
87	87	87	87	87	87	87
88	88	88	88	88	88	88
89	89	89	89	89	89	89
90	90	90	90	90	90	90
91	91	91	91	91	91	91
92	92	92	92	92	92	92
93	93	93	93	93	93	93
94	94	94	94	94	94	94
95	95	95	95	95	95	95
96	96	96	96	96	96	96
97	97	97	97	97	97	97
98	98	98	98	98	98	98
99	99	99	99	99	99	99
100	100	100	100	100	100	100

NOTE: The above is a summary of the results of the analysis.

Table 4.

Ratio of digestion of different wholesale cuts of beef.

Experiment 4.

Exp. No.	Lab. No.	Wholesale cut.	Strength of Acid. Pepsin. Per cent.		Time of digestion.	Per cent of digested nitrogen.
4	2139/1	Plate	0.2	1 gm-1	1 hr.	85.27
"	2139/2	"	"	"	1 "	82.90
"	2139/3	"	"	"	1 "	-----
Average-----						84.09
"	2139/4	Plate	"	"	2 "	91.11
"	2139/5	"	"	"	2 "	87.82
"	2139/6	"	"	"	2 "	87.29
Average-----						88.74
"	2139/7	"	"	"	4 "	87.04
"	2139/8	"	"	"	4 "	89.88
"	2139/9	"	"	"	4 "	89.85
Average-----						88.92
"	2140/1	Chuck	"	"	1 "	-----
"	2140/2	"	"	"	1 "	86.18
"	2140/3	"	"	"	1 "	87.10
Average-----						86.64
"	2140/4	"	"	"	2 "	90.07
"	2144/5	"	"	"	2 "	88.84
"	2140/6	"	"	"	2 "	90.87
Average-----						89.92
"	2141/1	Clod	"	"	1 "	12.15
"	2141/2	"	"	"	1 "	-----
"	2141/3	"	"	"	1 "	21.85
Average-----						17.00
"	2142/1	Neck	"	"	1 "	82.88
"	2142/2	"	"	"	1 "	80.33
"	2142/3	"	"	"	1 "	84.10
Average-----						82.43

STATE OF DELETION OF WHOLESALE PRICE OF BEEF

Continued

Year	Month	Wholesale Price of Beef	State of Deletion	Year	Month	Wholesale Price of Beef	State of Deletion
1900	1	10.00	1	1900	1	10.00	1
1900	2	10.00	1	1900	2	10.00	1
1900	3	10.00	1	1900	3	10.00	1
1900	4	10.00	1	1900	4	10.00	1
1900	5	10.00	1	1900	5	10.00	1
1900	6	10.00	1	1900	6	10.00	1
1900	7	10.00	1	1900	7	10.00	1
1900	8	10.00	1	1900	8	10.00	1
1900	9	10.00	1	1900	9	10.00	1
1900	10	10.00	1	1900	10	10.00	1
1900	11	10.00	1	1900	11	10.00	1
1900	12	10.00	1	1900	12	10.00	1
1901	1	10.00	1	1901	1	10.00	1
1901	2	10.00	1	1901	2	10.00	1
1901	3	10.00	1	1901	3	10.00	1
1901	4	10.00	1	1901	4	10.00	1
1901	5	10.00	1	1901	5	10.00	1
1901	6	10.00	1	1901	6	10.00	1
1901	7	10.00	1	1901	7	10.00	1
1901	8	10.00	1	1901	8	10.00	1
1901	9	10.00	1	1901	9	10.00	1
1901	10	10.00	1	1901	10	10.00	1
1901	11	10.00	1	1901	11	10.00	1
1901	12	10.00	1	1901	12	10.00	1
1902	1	10.00	1	1902	1	10.00	1
1902	2	10.00	1	1902	2	10.00	1
1902	3	10.00	1	1902	3	10.00	1
1902	4	10.00	1	1902	4	10.00	1
1902	5	10.00	1	1902	5	10.00	1
1902	6	10.00	1	1902	6	10.00	1
1902	7	10.00	1	1902	7	10.00	1
1902	8	10.00	1	1902	8	10.00	1
1902	9	10.00	1	1902	9	10.00	1
1902	10	10.00	1	1902	10	10.00	1
1902	11	10.00	1	1902	11	10.00	1
1902	12	10.00	1	1902	12	10.00	1

Table 4.

Ratio of digestion of different wholesale cuts of beef.

Experiment 4.

Exp. No.	Lab. No.	Wholesale cuts.	Strength of Acid. Pepsin. Per cent.		Time of digestion.	Per cent of digested nitrogen.
4	2142/4	Neck	0.2	1 gm-1	2 hrs.	90.30
"	2142/5	"	"	"	2 "	89.40
"	2142/6	"	"	"	2 "	87.70
Average-----						89.13
"	2143/1	Fore shank	"	"	1 "	77.68
"	2143/2	"	"	"	1 "	82.91
"	2143/3	"	"	"	1 "	-----
Average-----						80.29
"	2143/4	"	"	"	2 "	85.76
"	2143/5	"	"	"	2 "	83.69
"	2143/6	"	"	"	2 "	82.25
Average-----						83.90
"	2143/7	"	"	"	4 "	91.59
"	2143/8	"	"	"	4 "	92.55
"	2143/9	"	"	"	4 "	90.31
Average-----						91.48

The plate compared favorably with the round as did the chuck, while the neck and fore-shank acted similarly to the flank. In the case of the clod the per cent digested was extremely low and variable. It is not intended however to draw such conclusions from the results of this experiment. The figures obtained here will be interesting to compare with those obtained in future experiments of this kind, but aside from that they are of little value.

It was thought at first that an explanation of some of the unexpected results might be in the fact that some of the wholesale cuts contained a large amount of fat and this retarded digestion and caused the triplicates to vary. It was noticed however that the cuts which were lean digested no more readily than those which were fat, and the triplicates were no more uniform.

It had been expected that precipitation of the acid albumin by neutralization would eliminate the cause of variation in the duplicates, for two reasons. In the first place, a cleaner separation could be made between the digested and undigested portions than before, and in the second place the rapidity of filtration would tend to decrease the error in manipulation. Although the triplicates given in the table for this experiment are fairly close, however, there is more variation than was desired. The reason for such variation

therefore was laid to imperfect neutralization. That is, it was supposed, the same neutralization point had not been produced in the different beakers and consequently the same per cent of acid albumin had not been precipitated from the various solutions. This hypothesis was strengthened by the fact that there was some turbidity in filtrates which, even upon refiltering, could not be removed. The acid albumin which produced this turbidity, it was argued, was variable in quantity in the different filtrates and consequently caused variation in the results.

Experiment 5.

Object. Since in previous experiments the coefficient of digestion for one hour had been in nearly all cases above 75 per cent the purpose of this experiment was to reduce the time of the first period.

Method. Twelve samples of beef (lean, round) were weighed out and treated with 100 c. c. of an acid pepsin solution containing 1 gram of pepsin per liter of 0.2 HCl. The laboratory number of the beef was 2170. Three samples (Nos. 2170/1 to 2170/3 inclusive) were digested for 1/2 hour, six (Nos. 2170/4 to 2170/6 and 2170/10 to 2170/12 inclusive) were digested for 1 hour, and three (Nos. 2170/7 to 2170/9 inclusive) were digested for 1 1/2 hours. The manipulation was the same as in the previous experiment and great care was exercised during the neutralization. The results are given in table 5.

Observations and Conclusions. Contrary to expectations the per cent digested in 1/2 hour is very high, higher than some previous figures for one hour digestion. It is evident, therefore, that the digestive action with an acid pepsin solution of the strength used here, is extremely rapid. This is further emphasized by the results in the first set which were digested

Table 5.

Rate of digestion of a sample of beef.

Experiment 5.

Exp. No.	Lab. No.	Strength of Acid. Pepsin.		Time of digestion.	Per cent of digested nitrogen.
5	2170/1	0.2	1 gm-1	1/2 hr.	89.26
"	2170/2	"	"	"	88.42
"	2170/3	"	"	"	88.15
Average-----					88.61
"	2170/4	"	"	1 hr.	92.72
"	2170/5	"	"	"	89.41
"	2170/6	"	"	"	-----
Average-----					91.07
"	2170/10	"	"	"	87.93
"	2170/11	"	"	"	88.66
"	2170/12	"	"	"	84.37
Average-----					86.73
"	2170/7	"	"	1 1/2 hr.	-----
"	2170/8	"	"	"	87.40
"	2170/9	"	"	"	94.04
Average-----					90.72

The digestion seems to be as complete at the end of one hour as at the end of 1 1/2 hours. The results for the second set digested for one hour,

for one hour, however, are considerably reduced. An explanation for this discrepancy can not be given.

It is evident again, in spite of the utmost care at neutralization, that the variation in the triplicates was larger than it should have been.

Experiment VI.

Numerous attempts were made after the last experiment to find an indicator which would be more delicate than litmus paper when the solutions were neutralized after digestion. None was found however, so in this experiment a different neutralizing agent was tried.

Object. The purpose of the experiment was to compare BaCO_3 with KOH as a means of neutralization.

Method. The beef used in this case was labelled 2184. Two samples were digested for 15 minutes, two for 1/2 hour, two for 1 hour, two for 2 hours and two for 6 hours. One of the two in each case was neutralized with KOH as before and the other with BaCO_3 (Kahlbaum). The method of using the latter was to weigh out about 1 1/2 grams each in small watch glasses and pour the different portions into the proper beakers at the right time. The strength of acid pepsin solution and method

Table 6.

Rate of digestion of a sample of beef. Comparison of KOH
and BaCO₃ as neutralizing agent.

Experiment 6.

Exp. No.	Lab. No.	Strength of Acid. Pepsin.		Time of di- gestion.	Neutralizing agent.	Per cent of di- gested N.
6	2184/1	0.2	1 gm-1	1/4 hr.	KOH	79.50
"	2184/2	"	"	"	BaCO ₃	80.43
"	2184/3	"	"	1/2 hr.	KOH	90.32
"	2184/4	"	"	"	BaCO ₃	86.75
"	2184/5	"	"	1 hr.	KOH	88.25
"	2184/6	"	"	"	BaCO ₃	87.76
"	2184/7	"	"	2 hrs.	KOH	91.24
"	2184/8	"	"	"	BaCO ₃	83.64
"	2184/9	"	"	6 hrs.	KOH	97.52
"	2184/10	"	"	"	BaCO ₃	94.80

TABLE

DATA FOR THE CALCULATION OF THE CORRELATION COEFFICIENT
AND THE STANDARD DEVIATION OF THE MEAN

EXPLANATION

1. No. of Observations	2. Sum of Observations	3. Sum of Squares of Observations	4. Sum of Products of Observations	5. Mean	6. Standard Deviation
10	100	1000	1000	10	10
20	200	4000	4000	20	20
30	300	9000	9000	30	30
40	400	16000	16000	40	40
50	500	25000	25000	50	50
60	600	36000	36000	60	60
70	700	49000	49000	70	70
80	800	64000	64000	80	80
90	900	81000	81000	90	90
100	1000	100000	100000	100	100

of manipulation were the same as in the previous experiment.

The results are shown in table 6.

Observations and Conclusions. Here again the digestion was remarkably high at the end of 15 minutes and can not be satisfactorily explained in the light of former results on the digestibility of raw beef. The duplicates in this series were close enough in most cases to show that BaCO_3 would make as good a neutralizing agent as KOH . Its advantages were at least two in number. In the first place it produced the same degree of alkalinity in each sample. This was the condition most desired because if the same conditions were present in all the samples as regards neutrality, the duplicates should check even though the very best neutralization point for the precipitation of all the acid albumin was not reached. In the second place the tedious work of adding just the proper amount of KOH was eliminated. It was decided therefore to use BaCO_3 in later experiments.

Experiment 7.

Object. The object of experiment 7 was to reduce the initial period of digestion still further and to make further tests of the value of BaCO_3 as a neutralizing agent.

Method. The beef used was labelled 2185. Eight samples were weighed out and digested in duplicate for the following

Table 7.

Rate of digestion of sample of beef.

Experiment 7.

Exp. No.	Lab. No.	Strength of Acid. Pepsin. Per cent.	Time of di- gestion.	Neutralizing agent.	Per cent of di- gested N.	
7	2185/1	0.2	1 gm-1	10 min.	BaCO ₃	64.70
'	2185/2	'	'	'	'	62.10
Average-----						63.40
'	2185/3	'	'	20 min.	'	74.07
'	2185/4	'	'	'	'	73.63
Average-----						73.85
'	2185/5	'	'	30 min.	'	80.11
'	2185/6	'	'	'	'	-----
Average-----						80.11
'	2185/7	'	'	60 min.	'	86.14
'	2185/8	'	'	'	'	87.33
Average-----						86.73

periods of time: 10 minutes, 20 minutes, 30 minutes, ^{and} 60 minutes.

The conditions and method of manipulation were the same as in the previous experiment except that all the solutions were neutralized with BaCO_3 after digestion.

The results are tabulated on the next page.

Observations and Conclusions. While the results given here are not sufficient in number to prove the efficiency of BaCO_3 , they are quite uniform and indicate an improvement over the KOH . The surprising fact again is the large coefficient of digestion during the first period of 10 minutes. This makes it still more evident that an acid pepsin solution containing 1 gram of pepsin to a liter of 0.2 per cent HCl digests raw meat with great rapidity.

Conclusions from Results Obtained thus far,
in regard to the method of conducting the experiments.

1. The old method of filtering the solutions after digestion without neutralization is tedious, cumbersome, and inaccurate.
2. Neutralization after digestion eliminates the difficulties connected with filtration.
3. Both formalin and phenol are effective antiseptics

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but neither is necessary when the neutralization method is used.

4. Neutralizing the solutions before filtering does not seem to increase the uniformity of results to any great extent.

5. BaCO_3 is as effective a neutralizing agent as KOH and much more convenient.

6. An acid pepsin solution containing 1 gram of pepsin per liter of $\text{N}/10$ HCl or of 0.2 per cent HCl digests raw beef with great rapidity. When the strength of the digestive fluid is reduced to $1/2$ gram of pepsin per liter of $\text{N}/50$ HCl the rapidity of the action is reduced but is still high.

7. When $\text{N}/10$ HCl alone is used as the digestive agent, the per cent digested is very low at the end of the first hour and does not increase with longer digestion.

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Experiment 8.

Bearing in mind what was learned in the previous work, experiment 8 was planned on a more extensive scale than any previous series.

Object. The object of the experiment was to compare the digestibility of a sample of beef in different digestive fluids, the time of digestion being kept constant. The experiment was divided into 8 parts, a, b, c, d, e, f, g, and h. The purposes of each part was as follows:

(a) To digest five samples with an acid pepsin solution containing 1/2 gram of pepsin per liter of N/20 HCl and determine the per cent digested, the per cent undigested and the per cent of albumoses produced.

(b) To repeat (a) using the N/20 acid alone instead of the acid pepsin.

(c) To repeat (a) with water alone as the digesting agent.

(d) To repeat (a) using a pepsin solution of 1/2 gram of pepsin to a liter of H₂O. No acid.

(e) To repeat (a) using an acid pepsin solution containing 1/2 gram of pepsin to a liter of N/40 HCl.

(f) To repeat (a) using an acid pepsin solution containing 1/2 gram of pepsin to 1 liter of N/100 HCl.

1. The purpose of this document is to provide information on the status of the project.

2. The project is currently in the planning stage and is expected to be completed by the end of the year.

3. The project is being managed by the Project Manager.

4. The project is being funded by the Department of Defense.

5. The project is being implemented by the Department of Defense.

6. The project is being monitored by the Department of Defense.

7. The project is being evaluated by the Department of Defense.

8. The project is being reported on by the Department of Defense.

9. The project is being discussed by the Department of Defense.

10. The project is being reviewed by the Department of Defense.

11. The project is being approved by the Department of Defense.

12. The project is being implemented by the Department of Defense.

13. The project is being monitored by the Department of Defense.

14. The project is being evaluated by the Department of Defense.

15. The project is being reported on by the Department of Defense.

16. The project is being discussed by the Department of Defense.

17. The project is being reviewed by the Department of Defense.

18. The project is being approved by the Department of Defense.

19. The project is being implemented by the Department of Defense.

20. The project is being monitored by the Department of Defense.

21. The project is being evaluated by the Department of Defense.

22. The project is being reported on by the Department of Defense.

(g) To repeat (a) using no meat.

(h) To make a water extract of the meat and with the residues repeat (a), (b), and (c).

Method. The method in general for this experiment was the same as that used for experiment 7. BaCO_3 was used to neutralize the solution after digestion. Instead of using the dry salt, however, as in the previous work, a BaCO_3 paste was prepared for this work by Mr. H. H. Mitchell. In all cases 2 c. c. of the paste was used to neutralize the solution. The time of digestion of all samples was one hour. As it was desired to obtain results for the per cent digested, the per cent undigested and the per cent of albumoses in each section of this experiment the first were always lettered x, the second z, and the third y. Each section however was given a different lab. no.

Method for (a). Five samples of beef were weighed out as usual, and labelled from 2186/1 to 2186/5 inclusive. They were digested for one hour in an acid pepsin solution containing $1/2$ gram of pepsin to a liter of N/20 HCl. The manipulation was the same as in experiment 7 up to the point of filtering. Instead of heating the contents of the beakers on the water bath for about $1/2$ hour before filtering they were evaporated to 15 c. c. Then they were filtered and the filtrates caught in 110 c. c. graduated flasks. The residues

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were washed thoroughly and the filtrates made up to the 110 c. c. mark. The residues were transferred to Kjeldahl flasks and the N determined as usual. Two fifty c. c. portions of the filtrate were then taken, one for nitrogen determination, and the other for the estimation of albumoses by the ZnSO_4 method. As the residues from filtration gave the undigested N they were lettered z. One 50 c. c. portion of the filtrate from each beaker gave the nitrogen digested so it was lettered x, and the other 50 c. c. portion gave the N in the albumoses so it was lettered y. Method for (b), (d), (e), (f), and (g). Same as for (a) except that different digestive fluids were used. Method for (h). Twelve samples of the meat were weighed out and a water extract made. The samples were kept separate and labelled from 2193/1 to 2193/12 inclusive. Four of the residues were then treated exactly as in (a). These were numbered 2193/1z to 2193/4z inclusive. The portions of the filtrates taken for the N determination were labelled 2193/1x to 2193/4x and the portions used for the albumoses were marked 2193/1y to 2193/4y. Four more of the residues (Nos. 2193/5 to 2193/8 inclusive) were treated as in (b) and the different portions lettered as before. The remaining four (Nos. 2193/9 to 2193/12 inclusive) were treated as in (c).

The results of the entire experiment are given in tables 8 and 9.

with the same result as in the case of the other two.

It is, however, not possible to find a single result.

The following is a list of the results of the

experiments, which are given in the following

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Table 8.

Experiment 8.

Exp. No.	Lab. No.	Strength of Acid.Pepsin.	Per cent of undigested nitrogen.	Per cent of digested nitrogen.	Per cent of total N found in albumoses.
8a	2186/1z	N/20 1/2 gm-l	6.49		
"	2186/2z	" "	6.92		
"	2186/3z	" "	5.87		
"	2186/4z	" "	5.95		
"	2186/5z	" "	6.80		
	Average-----		6.41		
"	2186/1x	" "		80.92#	
"	2186/2x	" "		96.15	
"	2186/3x	" "		96.16	
"	2186/4x	" "		96.46	
"	2186/5x	" "		48.27 #	
	Average-----			96.26	
"	2186/1y	" "			64.87
"	2186/2y	" "			58.12
"	2186/3y	" "			60.48
"	2186/4y	" "			58.44
"	2186/5y	" "			58.29
	Average-----				60.4
8b	2187/1z	" None	74.52		
"	2187/2z	" "	70.95		
"	2187/3z	" "	68.22		
"	2187/4z	" "	70.02		
"	2187/5z	" "	75.53		
	Average-----		71.85		
"	2187/1x	" None		24.86	
"	2187/2x	" "		27.85	
"	2187/3x	" "		21.05	
"	2187/4x	" "		-----	
"	2187/5x	" "		22.22	
	Average-----			24.00	

This number is not included in the averages.

• **•**

• **Spencer Tracy**

Year	Month	Day	Time	Location	Remarks
1900	Jan	1	10:00	San Francisco	Arrived from New York
1900	Jan	2	10:00	San Francisco	Left for New York
1900	Jan	3	10:00	San Francisco	Arrived from New York
1900	Jan	4	10:00	San Francisco	Left for New York
1900	Jan	5	10:00	San Francisco	Arrived from New York
1900	Jan	6	10:00	San Francisco	Left for New York
1900	Jan	7	10:00	San Francisco	Arrived from New York
1900	Jan	8	10:00	San Francisco	Left for New York
1900	Jan	9	10:00	San Francisco	Arrived from New York
1900	Jan	10	10:00	San Francisco	Left for New York
1900	Jan	11	10:00	San Francisco	Arrived from New York
1900	Jan	12	10:00	San Francisco	Left for New York
1900	Jan	13	10:00	San Francisco	Arrived from New York
1900	Jan	14	10:00	San Francisco	Left for New York
1900	Jan	15	10:00	San Francisco	Arrived from New York
1900	Jan	16	10:00	San Francisco	Left for New York
1900	Jan	17	10:00	San Francisco	Arrived from New York
1900	Jan	18	10:00	San Francisco	Left for New York
1900	Jan	19	10:00	San Francisco	Arrived from New York
1900	Jan	20	10:00	San Francisco	Left for New York
1900	Jan	21	10:00	San Francisco	Arrived from New York
1900	Jan	22	10:00	San Francisco	Left for New York
1900	Jan	23	10:00	San Francisco	Arrived from New York
1900	Jan	24	10:00	San Francisco	Left for New York
1900	Jan	25	10:00	San Francisco	Arrived from New York
1900	Jan	26	10:00	San Francisco	Left for New York
1900	Jan	27	10:00	San Francisco	Arrived from New York
1900	Jan	28	10:00	San Francisco	Left for New York
1900	Jan	29	10:00	San Francisco	Arrived from New York
1900	Jan	30	10:00	San Francisco	Left for New York
1900	Jan	31	10:00	San Francisco	Arrived from New York

Table
Experiment 8.

Exp. No.	Lab. No.	Strength of Acid.Pepsin.	Per cent of undigested nitrogen.	Per cent of digested nitrogen.	Per cent of total N found in albumoses.
8b	2187/1y	N/20	None		-----
"	2187/2y	"	"		16.07
"	2187/3y	"	"		11.72
"	2187/4y	"	"		-----
"	2187/5y	"	"		10.46
	Average	-----	-----	-----	12.75
8c	2188/1z	None	None	83.64	
"	2188/2z	"	"	85.17	
"	2188/3z	"	"	-----	
"	2188/4z	"	"	82.96	
"	2188/5z	"	"	83.85	
	Average	-----	-----	83.90	
"	2188/1x	"	"	16.07	
"	2188/2x	"	"	16.31	
"	2188/3x	"	"	-----	
"	2188/4x	"	"	15.56	
"	2188/5x	"	"	16.51	
	Average	-----	-----	16.11	
"	2188/1y	"	"		5.10
"	2188/2y	"	"		5.01
"	2188/3y	"	"		-----
"	2188/4y	"	"		5.07
"	2188/5y	"	"		5.49
	Average	-----	-----	-----	5.17
8d	2189/1z	"	1/2 gm-1	76.95	
"	2189/2z	"	"	76.89	
"	2189/3z	"	"	77.12	
"	2189/4z	"	"	-----	
"	2189/5z	"	"	77.30	
	Average	-----	-----	77.06	

Table

Experiment 8.

Exp. No.	Ind. No.	Alld. Power, W.	Per cent of Induced, W.	Per cent of Total W. Induced, W.
1	2187/1	100	100	100
2	2187/2	100	100	100
3	2187/3	100	100	100
4	2187/4	100	100	100
5	2187/5	100	100	100
Average				
6	2187/6	100	100	100
7	2187/7	100	100	100
8	2187/8	100	100	100
9	2187/9	100	100	100
10	2187/10	100	100	100
Average				
11	2187/11	100	100	100
12	2187/12	100	100	100
13	2187/13	100	100	100
14	2187/14	100	100	100
15	2187/15	100	100	100
Average				
16	2187/16	100	100	100
17	2187/17	100	100	100
18	2187/18	100	100	100
19	2187/19	100	100	100
20	2187/20	100	100	100
Average				
21	2187/21	100	100	100
22	2187/22	100	100	100
23	2187/23	100	100	100
24	2187/24	100	100	100
25	2187/25	100	100	100
Average				
26	2187/26	100	100	100
27	2187/27	100	100	100
28	2187/28	100	100	100
29	2187/29	100	100	100
30	2187/30	100	100	100
Average				
31	2187/31	100	100	100
32	2187/32	100	100	100
33	2187/33	100	100	100
34	2187/34	100	100	100
35	2187/35	100	100	100
Average				
36	2187/36	100	100	100
37	2187/37	100	100	100
38	2187/38	100	100	100
39	2187/39	100	100	100
40	2187/40	100	100	100
Average				
41	2187/41	100	100	100
42	2187/42	100	100	100
43	2187/43	100	100	100
44	2187/44	100	100	100
45	2187/45	100	100	100
Average				
46	2187/46	100	100	100
47	2187/47	100	100	100
48	2187/48	100	100	100
49	2187/49	100	100	100
50	2187/50	100	100	100
Average				

Table 8.

Experiment 8.

Exp. No.	Lab. No.	Strength of Acid.Pepsin.	Per cent of undigested nitrogen.	Per cent of digested nitrogen.	Per cent of total N found in albumoses.
8d	2189/1x	None	1/2 gm-1	27.34	
"	2189/2x	"	"	25.25	
"	2189/3x	"	"	24.60	
"	2189/4x	"	"	26.60	
"	2189/5x	"	"	23.20	
	Average	-----	-----	25.40	
"	2189/1y	"	"		11.17
"	2189/2y	"	"		9.02
"	2189/3y	"	"		-----
"	2189/4y	"	"		-----
"	2189/5y	"	"		7.52
	Average	-----	-----		7.24
8e	2190/1z	N/40	"	9.89	
"	2190/2z	"	"	9.35	
"	2190/3z	"	"	10.17	
"	2190/4z	"	"	7.39	
"	2190/5z	"	"		
	Average	-----	-----	9.20	
"	2190/1x	"	"	-----	
"	2190/2x	"	"	92.67	
"	2190/3x	"	"	-----	
"	2190/4x	"	"	95.62	
"	2190/5x	"	"	96.85	
	Average	-----	-----	95.05	
"	2190/1y	"	"		-----
"	2190/2y	"	"		52.57
"	2190/3y	"	"		51.69
"	2190/4y	"	"		55.56
"	2190/5y	"	"		-----
	Average	-----	-----		53.27

Table 6.

Experiment 11.

Exp. No.	Lab. No.	Strength of Acid. Residue undigested nitrogen.	Per cent of nitrogen digested.	Per cent of total N found in digest.
84	2180/1x	None	37.24	
"	2180/2x	"	32.55	
"	2180/3x	"	34.60	
"	2180/4x	"	32.00	
"	2180/5x	"	32.00	
Average				32.40
"	2180/1x	"		11.17
"	2180/2x	"		9.08
"	2180/3x	"		---
"	2180/4x	"		---
"	2180/5x	"		7.52
Average				7.44
85	2190/1x	1.40	0.78	
"	2190/2x	"	0.78	
"	2190/3x	"	0.78	
"	2190/4x	"	0.78	
"	2190/5x	"	0.78	
Average				0.78
"	2190/1x	"		---
"	2190/2x	"	36.67	
"	2190/3x	"	---	
"	2190/4x	"	38.80	
"	2190/5x	"	36.75	
Average				36.00
"	2190/1x	"		---
"	2190/2x	"		32.57
"	2190/3x	"		31.12
"	2190/4x	"		32.52
"	2190/5x	"		---
Average				32.40

Table 8.

Experiment 8.

Exp. No.	Lab. No.	Strength of Acid.Pepsin.	Per cent of undigested nitrogen.	Per cent of digested nitrogen.	Per cent of total N found in albumoses.
8f	2191/1z	N/100 1/2 gm-1	31.87		
"	2191/2z	"	25.68		
"	2191/3z	"	18.26		
"	2191/4z	"	17.48		
"	2191/5z	"	22.74		
	Average	-----	23.21		
"	2191/1x	"		70.14	
"	2191/2x	"		75.48	
"	2191/3x	"		76.54	
"	2191/4x	"		84.78	
"	2191/5x	"		33.78#	
	Average	-----		77.48	
"	2191/1y	"			-----
"	2191/2y	"			-----
"	2191/3y	"			42.94
"	2191/4y	"			45.79
"	2191/5y	"			42.47
	Average	-----			43.73
8h	2193/1z	N/20 1/2 gm-1	6.77		
"	2193/2z	"	6.34		
"	2193/3z	"	5.66		
"	2193/4	"	6.62		
	Average	-----	6.35		
"	2193/1x	"		76.82	
"	2193/2x	"		76.70	
"	2193/3x	"		75.28	
"	2193/4x	"		77.98	
	Average	-----		76.69	

This number is not included in the numbers averaged.

Table 1

Experiment 8.

Exp. No.	Lab. No.	Strength of Per cent of Acid. Pepsin. undigested nitrogen.	Per cent of digested nitrogen.	Per cent of total N found in nitrogen.
87	8191/12	81.87		
"	8191/12	82.88		
"	8191/12	18.98		
"	8191/12	17.48		
"	8191/12	88.74		
Average		83.91		
"	8191/12			70.14
"	8191/12			78.48
"	8191/12			78.34
"	8191/12			84.78
"	8191/12			83.78
Average				77.48
"	8191/12			
"	8191/12			
"	8191/12			43.74
"	8191/12			43.78
"	8191/12			43.40
Average				43.72
88	8192/12	8.77		
"	8192/12	8.34		
"	8192/12	8.88		
"	8192/12	8.88		
Average		8.82		
"	8192/12			78.82
"	8192/12			78.70
"	8192/12			82.82
"	8192/12			77.88
Average				78.82

* This column is not included in the average column.

Table 8.

Experiment 8.

Exp. No.	Lab. No.	Strength of Acid.Pepsin.	Per cent of undigested nitrogen.	Per cent of digested nitrogen.	Per cent of total N found in albumoses.
8h	2193/1y	N/20	1/2 gm-1		48.46
"	2193/2y	"	"		45.66
"	2193/3y	"	"		42.47
"	2193/4y	"	"		45.54
	Average	-----	-----	-----	45.53
"	2193/5z	N/100	"	-----	
"	2193/6z	"	"	-----	
"	2193/7z	"	"	-----	
"	2193/8z	"	"	53.04	
	Average	-----	-----	53.04	
"	2193/5x	"	"	-----	
"	2193/6x	"	"	21.25	
"	2193/7x	"	"	-----	
"	2193/8x	"	"	24.83	
	Average	-----	-----	23.04	
"	2193/5y	"	"	-----	
"	2193/6y	"	"		19.38
"	2193/7y	"	"	-----	
"	2193/8y	"	"		22.34
	Average	-----	-----	-----	20.86
"	2193/9z	"	"	72.28	
"	2193/10z	"	"	-----	
"	2193/11z	"	"	-----	
"	2193/12z	"	"	73.41	
	Average	-----	-----	72.84	
"	2193/9x	"	"	6.89	
"	2193/10x	"	"	-----	
"	2193/11x	"	"	-----	
"	2193/12x	"	"	7.51	
	Average	-----	-----	7.20	

Table 1.
Experiment 6.

Exp. No.	Lab. No.	Strength of per cent of Ald. Form. and water nitrogen.	Per cent of total N found in nitrogen.
1	213712	1.00	46.46
2	213727	1.00	45.11
3	213737	1.00	45.47
4	213746	1.00	45.76
Average			
5	213752	1.00	45.72
6	213758	1.00	45.72
7	213772	1.00	45.72
8	213782	1.00	45.72
Average			
9	213782	1.00	45.72
10	213782	1.00	45.72
11	213782	1.00	45.72
12	213782	1.00	45.72
Average			
13	213782	1.00	45.72
14	213782	1.00	45.72
15	213782	1.00	45.72
16	213782	1.00	45.72
Average			
17	213782	1.00	45.72
18	213782	1.00	45.72
19	213782	1.00	45.72
20	213782	1.00	45.72
Average			
21	213782	1.00	45.72
22	213782	1.00	45.72
23	213782	1.00	45.72
24	213782	1.00	45.72
Average			
25	213782	1.00	45.72
26	213782	1.00	45.72
27	213782	1.00	45.72
28	213782	1.00	45.72
Average			
29	213782	1.00	45.72
30	213782	1.00	45.72
31	213782	1.00	45.72
32	213782	1.00	45.72
Average			
33	213782	1.00	45.72
34	213782	1.00	45.72
35	213782	1.00	45.72
36	213782	1.00	45.72
Average			
37	213782	1.00	45.72
38	213782	1.00	45.72
39	213782	1.00	45.72
40	213782	1.00	45.72
Average			
41	213782	1.00	45.72
42	213782	1.00	45.72
43	213782	1.00	45.72
44	213782	1.00	45.72
Average			
45	213782	1.00	45.72
46	213782	1.00	45.72
47	213782	1.00	45.72
48	213782	1.00	45.72
Average			
49	213782	1.00	45.72
50	213782	1.00	45.72
51	213782	1.00	45.72
52	213782	1.00	45.72
Average			
53	213782	1.00	45.72
54	213782	1.00	45.72
55	213782	1.00	45.72
56	213782	1.00	45.72
Average			
57	213782	1.00	45.72
58	213782	1.00	45.72
59	213782	1.00	45.72
60	213782	1.00	45.72
Average			
61	213782	1.00	45.72
62	213782	1.00	45.72
63	213782	1.00	45.72
64	213782	1.00	45.72
Average			
65	213782	1.00	45.72
66	213782	1.00	45.72
67	213782	1.00	45.72
68	213782	1.00	45.72
Average			
69	213782	1.00	45.72
70	213782	1.00	45.72
71	213782	1.00	45.72
72	213782	1.00	45.72
Average			
73	213782	1.00	45.72
74	213782	1.00	45.72
75	213782	1.00	45.72
76	213782	1.00	45.72
Average			
77	213782	1.00	45.72
78	213782	1.00	45.72
79	213782	1.00	45.72
80	213782	1.00	45.72
Average			
81	213782	1.00	45.72
82	213782	1.00	45.72
83	213782	1.00	45.72
84	213782	1.00	45.72
Average			
85	213782	1.00	45.72
86	213782	1.00	45.72
87	213782	1.00	45.72
88	213782	1.00	45.72
Average			
89	213782	1.00	45.72
90	213782	1.00	45.72
91	213782	1.00	45.72
92	213782	1.00	45.72
Average			
93	213782	1.00	45.72
94	213782	1.00	45.72
95	213782	1.00	45.72
96	213782	1.00	45.72
Average			
97	213782	1.00	45.72
98	213782	1.00	45.72
99	213782	1.00	45.72
100	213782	1.00	45.72
Average			

Table 8.

Experiment 8.

Exp. No.	Lab. No.	Strength of Acid.Pepsin.	Per cent of undigested nitrogen.	Per cent of digested nitrogen.	Per cent of total N found in albumoses.
8h	2193/9y	N/100	1/2	gm-1	6.03
"	2193/10y	"	"	"	----
"	2193/11y	"	"	"	----
"	2193/12y	"	"	"	----
Average					6.03

Table 2.

Experiment 2.

Exp. No.	Lab. No.	Amount of Potash or Soda used	Amount of Potash or Soda used	Amount of Potash or Soda used
1	1	1.00	1.00	1.00
2	2	1.00	1.00	1.00
3	3	1.00	1.00	1.00
4	4	1.00	1.00	1.00
5	5	1.00	1.00	1.00
6	6	1.00	1.00	1.00
7	7	1.00	1.00	1.00
8	8	1.00	1.00	1.00
9	9	1.00	1.00	1.00
10	10	1.00	1.00	1.00
11	11	1.00	1.00	1.00
12	12	1.00	1.00	1.00
13	13	1.00	1.00	1.00
14	14	1.00	1.00	1.00
15	15	1.00	1.00	1.00
16	16	1.00	1.00	1.00
17	17	1.00	1.00	1.00
18	18	1.00	1.00	1.00
19	19	1.00	1.00	1.00
20	20	1.00	1.00	1.00

Table 9.

61

Experiment 8. Summary.

Exp. No.	Lab. No.	Per cent of undiges- ted N.	Per cent of digested N.	Digested and undi- gested N.	Per cent of total N as albu- moses.	Digested N - albumoses = per cent N as peptones and end product.
8a	2186/1	6.49	80.92	87.41	64.87	16.05
"	2186/2	6.92	96.15	103.07	58.12	38.03
"	2186/3	5.87	96.16	102.03	60.48	35.68
"	2186/4	5.95	96.46	102.41	58.44	38.02
"	2186/5	6.80	48.27#	-----	58.29	-----
Average-----		6.41	96.26	102.67	60.40	35.86
8b	2187/1	74.52	24.86	99.38	-----	-----
"	2187/2	70.95	27.85	98.80	16.07	11.78
"	2187/3	68.22	21.05	89.27	11.72	9.33
"	2187/4	70.02	-----	-----	-----	-----
"	2187/5	75.53	22.22	97.75	10.46	11.76
Average-----		71.85	24.06	95.85	12.75	11.25
8c	2188/1	83.64	16.07	99.71	5.10	10.97
"	2188/2	85.17	16.31	101.48	5.01	11.30
"	2188/3	-----	-----	-----	-----	-----
"	2188/4	82.96	15.56	98.53	5.07	10.49
"	2188/5	83.85	16.51	100.36	5.49	11.02
Average-----		83.90	16.11	100.01	5.17	10.94
8d	2189/1	76.95	27.34	104.29	11.17	16.17
"	2189/2	76.89	25.25	102.14	9.02	16.23
"	2189/3	77.12	24.60	101.72	-----	-----
"	2189/4	-----	26.60	-----	-----	-----
"	2189/5	77.30	23.20	100.50	7.52	15.68
Average-----		77.06	25.40	102.46	7.24	18.16
8e	2190/1	-----	-----	-----	-----	-----
"	2190/2	9.89	92.67	102.56	52.57	40.10
"	2190/3	9.35	-----	-----	51.69	-----
"	2190/4	10.17	95.62	105.79	55.56	40.06
"	2190/5	7.39	96.85	104.24	-----	-----
Average-----		9.20	95.05	104.25	53.27	41.78

This number is not included in the numbers averaged.

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[illegible][illegible]

Table 9.

Experiment 8. Summary.

Exp. No.	Lab. No.	Per cent of undiges- ted N.	Per cent of digested N.	Digested and undi- gested. N.	Per cent of total N as albu- moses.	Digested N - albumoses = per cent N as peptones and end products.
8f	2191/1	31.87	70.14	102.01	-----	-----
"	2191/2	25.68	75.48	101.16	-----	-----
"	2191/3	18.26	76.54	94.80	42.94	33.60
"	2191/4	17.48	84.78	102.26	45.79	38.99
"	2191/5	22.74	33.78#		42.47	-----
Average	-----	23.21	76.74	100.69	43.73	33.01
8h	2193/1	6.77	76.82	83.59	48.46	28.36
"	2193/2	6.34	76.70	83.04	45.66	31.04
"	2193/3	5.66	75.28	80.94	42.47	32.88
"	2193/4	6.62	77.98	84.60	45.54	33.44
Average	-----	6.35	76.69	83.04	45.53	31.16
"	2193/5	-----	-----	-----	-----	-----
"	2193/6	-----	21.25	-----	19.38	1.87
"	2193/7	-----	-----	-----	-----	-----
"	2193/8	53.04	24.83	77.87	22.34	2.49
Average	-----	53.04	23.04	76.08	20.86	2.18
"	2193/9	72.28	6.89	79.17	6.03	.86
"	2193/10	-----	-----	-----	-----	-----
"	2193/11	-----	-----	-----	-----	-----
"	2193/12	73.41	7.51	80.92	-----	-----
Average	-----	72.84	7.20	80.04	6.03	1.17

This number is not included in the numbers averaged.

Year	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1900	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	39.00	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00	61.00	62.00	63.00	64.00	65.00	66.00	67.00	68.00	69.00	70.00	71.00	72.00	73.00	74.00	75.00	76.00	77.00	78.00	79.00	80.00	81.00	82.00	83.00	84.00	85.00	86.00	87.00	88.00	89.00	90.00	91.00	92.00	93.00	94.00	95.00	96.00	97.00	98.00	99.00	100.00																																																																																																														

Observations and Conclusions. From the summary, table 9, it is evident that in (a), when an acid pepsin solution containing 1 gram of pepsin to a liter of N/20 HCl was used, about 96% of the meat was digested in one hour. Sixty per cent had been converted into albumoses, losing about 36% as peptones and further end products. The sum of the digested and the undigested N was 102.67%. Although there was considerable variation in duplicates, in some cases these figures probably represent approximately what was present.

In (b), where the acid was used alone, only about 24 per cent was digested, 13 per cent being albumoses and 11 per cent further end products. The sum of the digested and undigested portions averaged about 96 per cent.

In (c) when water alone was used, the digestible portion was 16 per cent and the undigested 84 per cent. Five per cent was found as albumoses and 11 per cent as further end products. A comparison of (b) and (c) is interesting in determining the effect of the HCl alone on the digestive action. It is clear that the difference between 24 per cent and 16 per cent is 8 per cent and represents approximately the amount of digestion produced by the HCl itself. Further it is to be noticed that the difference between the albumoses in (b) and those in (c) is also about 8 per cent. It is reasonable to assume therefore, that the HCl digested about 8 per cent of the

CHAPTER I. THE DISCOVERY OF AMERICA.

IN THE YEAR 1492, CHRISTOPHER COLUMBUS, A NATIVE OF GENOVA, ITALY, WAS SENT BY THE KING OF SPAIN TO DISCOVER A WESTERN PASSAGE TO THE INDIES.

HE SAILLED FROM PALOS, SPAIN, ON SEPTEMBER 3RD, 1492, AND AFTER A VOYAGE OF SEVENTY DAYS, HE DISCOVERED THE ISLAND OF CRISTO BALAN, IN THE WEST INDIES.

HE REMAINED THERE FOR THREE MONTHS, AND THEN SAILLED ON TO THE MAINLAND, WHERE HE FOUND THE INDIANS.

HE WAS WELL RECEIVED BY THEM, AND HE STAYED WITH THEM FOR SEVERAL DAYS.

HE THEN SAILLED BACK TO SPAIN, AND REPORTED TO THE KING AND QUEEN THAT HE HAD DISCOVERED A NEW WORLD.

THE KING AND QUEEN WERE VERY PLEASED WITH HIS DISCOVERY, AND THEY SENT HIM MORE SHIPS TO DISCOVER OTHER ISLANDS.

HE THEN SAILLED BACK TO THE MAINLAND, AND HE FOUND THE INDIANS.

IN THE YEAR 1493, HE SAILLED BACK TO THE MAINLAND, AND HE FOUND THE INDIANS.

HE WAS WELL RECEIVED BY THEM, AND HE STAYED WITH THEM FOR SEVERAL DAYS.

HE THEN SAILLED BACK TO SPAIN, AND REPORTED TO THE KING AND QUEEN THAT HE HAD DISCOVERED A NEW WORLD.

THE KING AND QUEEN WERE VERY PLEASED WITH HIS DISCOVERY, AND THEY SENT HIM MORE SHIPS TO DISCOVER OTHER ISLANDS.

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THE KING AND QUEEN WERE VERY PLEASED WITH HIS DISCOVERY, AND THEY SENT HIM MORE SHIPS TO DISCOVER OTHER ISLANDS.

meat more than the water alone and all of this increase was found as albumoses.

The results from (d) show that when pepsin alone is used (1 gm-l), only about 25 per cent of the sample is digested. This is practically the same amount digested by the N/20 acid alone. In this case however a larger per cent remains undigested than when the acid alone was used, the amount of albumoses produced is smaller, and the peptones and further end products increased. It seems then that the pepsin of this strength has no greater digestive power than the N/20 acid alone but that a large per cent of the digested portion is carried beyond the albumose stage.

When the acidity of the acid pepsin solution used in (a) is decreased to N/40 as in (e), the amount digested is about the same as with the stronger acid. This is in harmony with the previous results of this study. It seems however that in this case the quantity of albumoses produced is less than with the stronger acid, and the amount of peptones and further end products, greater. This indicates that the weaker acid allows the pepsin to work to better advantage than the stronger acid.

In (f), the strength of the acid was decreased to N/100. A decided decrease in digestibility resulted although the soluble portion was still high. This shows that an extremely

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weak acid is necessary to retard the action to an appreciable extent, a conclusion that our former results tend to support. The proportion of albumoses and peptones present after digestion in (f), are about the same as in (e).

No results from section (g) of this experiment were obtained so this letter was omitted from the table.

From (h) we find that approximately 80 per cent of the meat sample remained after extracting with water. The water extract therefore must have amounted to about 20 per cent. Of the 80 per cent remaining, 76 per cent was digested with the acid pepsin solution containing 1 gram of pepsin to a liter of N/20 acid, 23 per cent with the acid alone, and 7 per cent with water alone. The proportion therefore is 76 : 23 : 7. When the fresh meat was digested in (a), (b), and (c) the proportion under the same conditions was 96 : 24 : 16. The advantage in the former ^{proportion} is first, in favor of the acid alone, next the acid pepsin, and lastly the water. The acid alone digested as much of the residue from the water extract as the fresh meat, the acid pepsin as much of the residue as the fresh meat minus the water extract, and the water alone only about $\frac{1}{2}$ as much as with the fresh meat. Further, when the acid pepsin was used, more than half of the digested portion was found as albumose. This is similar to the action on the fresh meat.

When acid alone was used nearly all of the digested portion was found as albumoses. This also agrees with the results with fresh meat. When water alone was used, a little larger per cent was found as albumoses than with the fresh meat.

On the whole the results of experiment 8 indicate many interesting things, some of them expected and some unexpected. It is not intended however to draw definite conclusions from the limited number of facts here shown. More results will have to be obtained. Furthermore the method used here is not sufficiently developed for the most accurate work.

Experiment 9.

Object. To determine the rate of digestion in a pepsin solution containing $1/2$ gram of pepsin to a liter of water, when the solution is made weakly acid at the end of the first hour.

Method. Twenty five samples of meat of from 2-2.5 grams each were weighed out into 25 c. c. Jena beakers and labelled from 2195/1 to 2195/25 inclusive. Five c. c. of water was added and the contents stirred one minute. To each beaker 100 c. c. H_2O were added containing $1/2$ gram pepsin per liter. They were all digested at 40° C. for one hour. At the end of one hour five samples (2195/1 to 2195/5 inclusive- were removed,

Table 10.

Rate of digestion of a sample of beef.

Experiment 9.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl at end of first hour.	Per cent of undigested N.	Per cent of digested N.
9	2195/1z	1 hr.	None	77.70	
"	2195/2z	"	"	76.79	
"	2195/3z	"	"	76.58	
"	2195/4z	"	"	75.48	
"	2195/5z	"	"	-----	
	Average	-----	-----	76.64	
"	2195/1x	"	"		26.04
"	2195/2x	"	"		26.93
"	2195/3x	"	"		26.70
"	2195/4x	"	"		28.21
	Average	-----	-----		26.97
"	2195/5x	"	"		24.54
"	2195/6z	2 hrs.	2 c. c.	64.81	
"	2195/7z	"	"	70.35	
"	2195/8z	"	"	64.31	
"	2195/9z	"	"	68.09	
	Average	-----	-----	66.89	
"	2195/10z	"	"	-----	
"	2195/6x	"	"		38.78
"	2195/7x	"	"		32.57
"	2195/8x	"	"		38.68
"	2195/9x	"	"		-----
	Average	-----	-----		36.67
"	2195/10x	"	"		16.80#
"	2195/11z	3 hrs.	"	62.89	
"	2195/12z	"	"	62.78	
"	2195/13z	"	"	62.53	
"	2195/14z	"	"	64.97	
	Average	-----	-----	63.29	
"	2195/15z	"	"	-----	

This number is not included in the numbers averaged.

Table 10.

Rate of digestion of a sample of beef.

Experiment 9.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl at end of first hour.	Per cent of undigested N.	Per cent of digested N.
9	2195/11x	3 hrs.	2 c. c.		44.05
"	2195/12x	"	"		41.30
"	2195/13x	"	"		40.31
"	2195/14x	"	"		39.50
	Average-----				31.29
"	2195/15x	"	"		36.41
"	2195/16z	4 hrs.	"	-----	
"	2195/17z	"	"	62.12	
"	2195/18z	"	"	60.35	
"	2195/19z	"	"	59.16	
	Average-----			60.54	
"	2195/20z	"	"	-----	
"	2195/16x	"	"		40.89
"	2195/17x	"	"		41.25
"	2195/18x	"	"		42.63
"	2195/19x	"	"		45.14
	Average-----				42.48
"	2195/20x	"	"		47.01
"	2195/21z	5 hrs.	"	60.51	
"	2195/22z	"	"	55.15	
"	2195/23z	"	"	53.56	
"	2195/24z	"	"	49.62	
	Average-----			54.71	
"	2195/25z	"	"	-----	
"	2195/21x	"	"		41.32
"	2195/22x	"	"		47.79
"	2195/23x	"	"		50.82
"	2195/24x	"	"		53.31
	Average-----				48.31
"	2195/25x	"	"		-----

neutralized with 2 c. c. BaCO_3 paste, and evaporated to 15 c. c. on the water bath. When the first five beakers were removed 2 c. c. of N/10 HCl were added to the contents of each of the beakers remaining in the digesting bath. At the end of the second hour, five more samples were removed, neutralized, and evaporated. These were Nos. 2195/6 to 2195/10. At the end of the third hour five more samples were removed, neutralized, and filtered (Nos. 2195/11 to 2195/15). This process was repeated at the end of each succeeding hour until all the beakers were removed.

When the contents of all the beakers were evaporated to 15 c. c., four from each lot of five were filtered into 110 c. c. measuring flasks and the residues washed thoroughly. The N was determined in the residues and in 50 c. c. portions of the filtrates. The last sample from each lot of five was diluted to 250 c. c., stirred, and filtered through a dry filter into a 200 c. c. measuring flask. The residues were not washed. The N was determined in the residues and in 200 c. c. portions of the filtrate.

In all cases the residues were lettered z and the filtrates x with the proper lab. no. The table of results follows table No. 10.

Observations and conclusions. In this experiment we get for the first time results which show the rate of digestion when the amount digested during the initial period

is small. The acidity of the solution is exceedingly small, being approximately $N/500$ after the first hour. In the table the results of the last sample of each lot of five was not averaged in with the others because it was treated in a little different manner as mentioned above. It is given below the average in each case, and does not show much uniformity with it in most cases.

By examining the tables we see that approximately 26 per cent of the meat is digested in one hour by the pepsin solution alone. This agrees very well with the results of experiment 8 (d). By making the solution $N/500$ acid, the digestion increases gradually until at the end of five hours it has reached nearly 50 per cent. It is evident therefore that in experimenting upon the rate of digestion of beef a very weak acidity is desirable.

Experiment 10.

Object. To determine the rate of digestion of beef in an acid pepsin solution in which the acidity was increased by a definite amount at regular intervals.

Method. The experiment was divided into four parts, a, b, c, and d.

(a) Five portions of thoroughly mixed lean beef

of from 2 to 2.5 grams each were weighed out into Jena beakers of 250 c. c. capacity and labelled 2190/1 to 2190/5 inclusive. Five c. c. NH_3 free H_2O were added and the contents stirred to a thick paste with a glass rod. To each beaker 100 c. c. H_2O containing $1/2$ gram pepsin per liter were added. The mixture was digested at 40° for 1 hour. At the end of 1 hour 2 c. c. of N/10 HCl were added. At the end of 2 hours digestion 2 c. c. more of N/10 HCl were added and this process ^{was} repeated at end of each succeeding hour until 8 c. c. N/10 HCl had been added. Digestion was continued 1 hour longer and the solution was then neutralized with 2 c. c. BaCO_3 paste. After evaporating to small volume it was filtered and the residue thoroughly washed with hot water. The N was determined in the residue and also in a 50 c. c. portion of the filtrate after it had been made up to 110 c. c. The residues were labelled z and the filtrates x.

(b) Same as above except that only six c. c. N/10 HCl were added in portions of 2 c. c. each. Therefore the period of digestion was cut from 6 to 5 hours. The laboratory numbers included 2196/6 and 2196/10.

(c) Same as above except that only 4 c. c. N/10 HCl were added. Digestion was cut from 5 to 4 hours. The laboratory numbers included 2196/11 to 2196/15.

(d) Same as in (c) except that no acid was added, and the

Table 11.

Rate of digestion with variable acidity.

Experiment 10.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl added in portions of 2 c.c. each, at regular intervals.	Per cent of undigested N.	Per cent of digested N.
10a	2196/1z	5 hrs.	8 c. c.	50.19	
"	2196/2z	"	"	48.41	
"	2196/3z	"	"	38.16	
"	2196/4z	"	"	45.24	
"	2196/5z	"	"	52.38	
	Average-----			47.07	
"	2196/1x	"	"		53.16
"	2196/2x	"	"		57.33
"	2196/3x	"	"		65.35
"	2196/4x	"	"		58.35
"	2196/5x	"	"		51.16
	Average-----				57.07
10b	2196/6z	4 hrs.	6 c. c.	54.29	
"	2196/7z	"	"	46.69	
"	2196/8z	"	"	53.84	
"	2196/9z	"	"	56.79	
"	2196/10z	"	"	51.04	
	Average-----			52.53	
"	2196/6x	"	"		49.50
"	2196/7x	"	"		57.44
"	2196/8x	"	"		49.09
"	2196/9x	"	"		-----
"	2196/10x	"	"		52.22
	Average-----				52.06

Table 11.

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Rate of digestion with variable acidity.

Experiment 10.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl added in portions of 2 c. c. each, at regular intervals.	Per cent of undigested N.	Per cent of digested N.
10c	2196/11z	3 hrs.	4 c. c.	56.22	
"	2196/12z	"	"	50.71	
"	2196/13z	"	"	53.21	
"	2196/14z	"	"	60.08	
"	2196/15z	"	"	54.72	
	Average-----			54.99	
"	2196/11x	"	"		50.05
"	2196/12x	"	"		54.61
"	2196/13x	"	"		51.30
"	2196/14x	"	"		44.66
"	2196/15x	"	"		47.63
	Average-----				49.65
10d	2196/16z	28 hrs.	None	69.36	
"	2196/17z	"	"	66.03	
"	2196/18z	"	"	65.61	
"	2196/19z	"	"	-----	
"	2196/20z	"	"	63.36	
	Average-----			66.09	
"	2196/16x	"	"		34.59
"	2196/17x	"	"		-----
"	2196/18x	"	"		37.80
"	2196/19x	"	"		33.61
"	2196/20x	"	"		36.63
	Average-----				35.66

digestion was continued for 21 hours,-- 13 hours at 40° and 15 at the temperature of the laboratory.

Observations and conclusions. From (d) we see that the pepsin without the acid digested 35 per cent of the meat in 28 hours, or 10 per cent more than it did in the two previous experiments for one hour. When the acid was added at regular intervals the digestion increased steadily from 49 per cent in three hours to 57 per cent in 5 hours. This took place in solutions which varied in acidity from N/500 to N/125.

The same irregularities in duplicates appears in this series as in previous experiments in spite of the fact that great care was exercised in manipulation.

Experiment 11.

Object. To determine the digestibility of beef in weak acid solution when the acidity is increased by a constant amount at regular intervals.

Method. The experiment was divided into four parts, a, b, c, and d and each part carried out exactly as in the preceding experiment, except that the pepsin was omitted from the digesting solution. The results are given in table 12.

Observations and Conclusions. The per cent digested in a, b, and c, is practically constant, showing that when the

Table 12.

Rate of digestion in acid alone with variable acidity.

Experiment 11.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl added in portions of 2 c.c. each at regular intervals.	Per cent of undigested N.	Per cent of digested N.
11a	2197/1z	5 hrs.	8 c. c.	83.81	
"	2197/2z	"	"	84.65	
"	2197/3z	"	"	84.21	
"	2197/4z	"	"	84.69	
"	2197/5z	"	"	85.18	
Average-----				84.51	
"	2197/1x	"	"		16.00
"	2197/2x	"	"		16.03
"	2197/3x	"	"		30.05 #
"	2197/4x	"	"		16.06
"	2197/5x	"	"		16.65
Average-----					16.19
11b	2197/6z	4 hrs.	6 c. c.	83.60	
"	2197/7z	"	"	84.85	
"	2197/8z	"	"	84.33	
"	2197/9z	"	"	85.41	
"	2197/10z	"	"	84.28	
Average-----				84.49	
"	2197/6x	"	"		15.87
"	2197/7x	"	"		15.95
"	2197/8x	"	"		15.82
"	2197/9x	"	"		-----
"	2197/10x	"	"		13.31
Average-----					15.27

This number is not included in the numbers averaged.

Table 12.

Rate of digestion in acid alone with variable acidity.

Experiment 11.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl added in portions of 2 c. c. each at regular intervals.	Per cent of undigested N.	Per cent of digested N.
11c	2197/11z	3 hrs.	4 c.c.	84.39	
"	2197/12z	"	"	82.56	
"	2197/13	"	"	82.62	
"	2197/14z	"	"	90.11	
"	2197/15z	"	"	85.18	
Average-----				84.97	
"	2197/11x	"	"		14.88
"	2197/12x	"	"		15.70
"	2197/13	"	"		14.86
"	2197/14	"	"		15.25
"	2197/15x	"	"		15.29
Average-----					15.20

Table 1

Table 1. Summary of the results of the analysis of variance for the different factors.

Table 1. Summary of the results of the analysis of variance for the different factors.

Source of variation	Sum of squares	D.F.	Mean square	F-value	Probability
Between groups	11.00	3	3.67	1.10	0.35
Within groups	11.00	12	0.92		
Total	22.00	15			
Corrected total	22.00	15			
Between groups	11.00	3	3.67	1.10	0.35
Within groups	11.00	12	0.92		
Total	22.00	15			
Corrected total	22.00	15			

acid solution is between N/500 and N/125 at all times the periodic increases in acidity do not cause an increase in digestion. This fact taken in connection with the results of Experiment 10 indicates that an increase of acidity from N/500 to N/125 causes an increase in digestibility only when the pepsin is present. As the pepsin without the acid has little power of digestion of its own, they must both be present.

Experiment 12.

Since the last four experiments had been carried on with great care, and the desired uniformity in duplicates had not been obtained, it was decided that something besides faulty neutralization was the cause of the variation. The only other explanation of the difficulty was that the sample was not sufficiently fine for good peptonization. Experiment 12 was therefore planned with the following object.

Object. To compare the ordinary method of manipulation with one in which the meat was ground with some hard granular substance. The purpose of such treatment was to keep the meat particles separated as completely as possible during digestion.

Method. Fifteen samples of meat were weighed out as usual, and numbered from 2198/1 to 2198/15 inclusive. The first five samples were treated with 5 c. c. of H_2O and stirred with a

Table 13.

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Comparison of method of getting sample finely divided.

Experiment 12.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl added in portions of 2 c. c. each at regular intervals.	Substance ground with meat.	Per cent undigested.
12	2198/1	3 hrs.	4 c. c.	None	52.05
"	2198/2	"	"	"	52.49
"	2198/3	"	"	"	-----
"	2198/4	"	"	"	51.75
"	2198/5	"	"	"	52.09
Average-----					52.10
"	2198/6	"	"	Silica	50.38
"	2198/7	"	"	"	57.38
"	2198/8	"	"	"	52.01
"	2198/9	"	"	"	44.10
"	2198/10	"	"	"	59.53
Average-----					52.68
"	2198/11	"	"	Pumice	46.96
"	2198/12	"	"	"	55.63
"	2198/13	"	"	"	57.18
"	2198/14	"	"	"	52.97
"	2198/15	"	"	"	53.94
Average-----					53.34

UNITED STATES DEPARTMENT OF AGRICULTURE

ANNUAL REPORT

Year	Amount	Percentage	Total	Balance	Remarks
1901	100.00	100.00	100.00	0.00	
1902	100.00	100.00	100.00	0.00	
1903	100.00	100.00	100.00	0.00	
1904	100.00	100.00	100.00	0.00	
1905	100.00	100.00	100.00	0.00	
1906	100.00	100.00	100.00	0.00	
1907	100.00	100.00	100.00	0.00	
1908	100.00	100.00	100.00	0.00	
1909	100.00	100.00	100.00	0.00	
1910	100.00	100.00	100.00	0.00	
1911	100.00	100.00	100.00	0.00	
1912	100.00	100.00	100.00	0.00	
1913	100.00	100.00	100.00	0.00	
1914	100.00	100.00	100.00	0.00	
1915	100.00	100.00	100.00	0.00	
1916	100.00	100.00	100.00	0.00	
1917	100.00	100.00	100.00	0.00	
1918	100.00	100.00	100.00	0.00	
1919	100.00	100.00	100.00	0.00	
1920	100.00	100.00	100.00	0.00	
1921	100.00	100.00	100.00	0.00	
1922	100.00	100.00	100.00	0.00	
1923	100.00	100.00	100.00	0.00	
1924	100.00	100.00	100.00	0.00	
1925	100.00	100.00	100.00	0.00	
1926	100.00	100.00	100.00	0.00	
1927	100.00	100.00	100.00	0.00	
1928	100.00	100.00	100.00	0.00	
1929	100.00	100.00	100.00	0.00	
1930	100.00	100.00	100.00	0.00	
1931	100.00	100.00	100.00	0.00	
1932	100.00	100.00	100.00	0.00	
1933	100.00	100.00	100.00	0.00	
1934	100.00	100.00	100.00	0.00	
1935	100.00	100.00	100.00	0.00	
1936	100.00	100.00	100.00	0.00	
1937	100.00	100.00	100.00	0.00	
1938	100.00	100.00	100.00	0.00	
1939	100.00	100.00	100.00	0.00	
1940	100.00	100.00	100.00	0.00	
1941	100.00	100.00	100.00	0.00	
1942	100.00	100.00	100.00	0.00	
1943	100.00	100.00	100.00	0.00	
1944	100.00	100.00	100.00	0.00	
1945	100.00	100.00	100.00	0.00	
1946	100.00	100.00	100.00	0.00	
1947	100.00	100.00	100.00	0.00	
1948	100.00	100.00	100.00	0.00	
1949	100.00	100.00	100.00	0.00	
1950	100.00	100.00	100.00	0.00	
1951	100.00	100.00	100.00	0.00	
1952	100.00	100.00	100.00	0.00	
1953	100.00	100.00	100.00	0.00	
1954	100.00	100.00	100.00	0.00	
1955	100.00	100.00	100.00	0.00	
1956	100.00	100.00	100.00	0.00	
1957	100.00	100.00	100.00	0.00	
1958	100.00	100.00	100.00	0.00	
1959	100.00	100.00	100.00	0.00	
1960	100.00	100.00	100.00	0.00	
1961	100.00	100.00	100.00	0.00	
1962	100.00	100.00	100.00	0.00	
1963	100.00	100.00	100.00	0.00	
1964	100.00	100.00	100.00	0.00	
1965	100.00	100.00	100.00	0.00	
1966	100.00	100.00	100.00	0.00	
1967	100.00	100.00	100.00	0.00	
1968	100.00	100.00	100.00	0.00	
1969	100.00	100.00	100.00	0.00	
1970	100.00	100.00	100.00	0.00	
1971	100.00	100.00	100.00	0.00	
1972	100.00	100.00	100.00	0.00	
1973	100.00	100.00	100.00	0.00	
1974	100.00	100.00	100.00	0.00	
1975	100.00	100.00	100.00	0.00	
1976	100.00	100.00	100.00	0.00	
1977	100.00	100.00	100.00	0.00	
1978	100.00	100.00	100.00	0.00	
1979	100.00	100.00	100.00	0.00	
1980	100.00	100.00	100.00	0.00	
1981	100.00	100.00	100.00	0.00	
1982	100.00	100.00	100.00	0.00	
1983	100.00	100.00	100.00	0.00	
1984	100.00	100.00	100.00	0.00	
1985	100.00	100.00	100.00	0.00	
1986	100.00	100.00	100.00	0.00	
1987	100.00	100.00	100.00	0.00	
1988	100.00	100.00	100.00	0.00	
1989	100.00	100.00	100.00	0.00	
1990	100.00	100.00	100.00	0.00	
1991	100.00	100.00	100.00	0.00	
1992	100.00	100.00	100.00	0.00	
1993	100.00	100.00	100.00	0.00	
1994	100.00	100.00	100.00	0.00	
1995	100.00	100.00	100.00	0.00	
1996	100.00	100.00	100.00	0.00	
1997	100.00	100.00	100.00	0.00	
1998	100.00	100.00	100.00	0.00	
1999	100.00	100.00	100.00	0.00	
2000	100.00	100.00	100.00	0.00	

glass rod until a thick paste had formed, as usual. One hundred c. c. of water containing $1/2$ gram of pepsin per liter were then added and the samples digested for three hours. At the end of the first hour 2 c. c. of N/10 HCl were added and at the end of the second hour, this was repeated. Neutralization and filtration were accomplished as usual. The N was determined in the residues but not in the filtrates. The second five samples were treated exactly as the first except that a little precipitated silica was ground into the meat as thoroughly as possible with a glass rod after the first 5 c. c. of water were added. The third set of five were treated exactly as the second set with pumice substituted for silica. The results of the experiment are given in table 13.

Observations and Conclusions. Since the purpose of the experiment was to determine which of the three treatments gave the most uniform results, a glance at the table shows that neither silica nor pumice further the desired end. In fact the results in the first set are much better than those in the other two. Another method therefore had to be tried for dividing the sample more finely.

Experiment 13.

Object. To eliminate the variations in duplicates by

Table 14.

Digestion results when meat was ground as finely as possible
with glass rod.

Experiment 13.

Exp. No.	Lab. No.	Time of di- gestion.	C. c. of N/10 HCl added in portions of 2 c. c. each at regular intervals.	Per cent of undigested N.	Per cent of digested N.
13	2208/1z	3 hrs.	4 c. c.	57.31	
"	2208/2z	"	"	53.31	
"	2208/3z	"	"	57.06	
"	2208/4z	"	"	52.65	
"	2208/5z	"	"	60.05	
	Average-----			56.07	
"	2208/1x	"	"		44.27
"	2208/2x	"	"		48.79
"	2208/3x	"	"		45.55
"	2208/4x	"	"		-----
"	2208/5x	"	"		43.12
	Average-----				45.43
"	2208/6z	"	"	42.14#	
"	2208/7z	"	"	57.85	
"	2208/8z	"	"	-----	
"	2208/9z	"	"	-----	
"	2208/10z	"	"	53.09	
	Average-----			55.47	
"	2208/6x	"	"		44.47
"	2208/7x	"	"		44.95
"	2208/8x	"	"		45.93
"	2208/9x	"	"		-----
"	2208/10x	"	"		41.54
	Average-----				44.22

This number is not included in the numbers averaged.

Table 1

Summary of the results of the analysis of variance for the different groups of subjects.

Source of Variation

Source of Variation	Sum of Squares	D.F.	Mean Square	F	Significance
Between Groups	15.78	4	3.94	1.12	.34
Within Groups	17.22	16	1.07		
Total	33.00	20			
Error	1.00	1	1.00		
Residual	16.00	19			
Grand Total	32.00	20			
Between Groups	1.00	4	.25	.72	.58
Within Groups	1.00	16	.06		
Total	2.00	20			
Error	.00	1	.00		
Residual	1.00	19			
Grand Total	2.00	20			
Between Groups	1.00	4	.25	.72	.58
Within Groups	1.00	16	.06		
Total	2.00	20			
Error	.00	1	.00		
Residual	1.00	19			
Grand Total	2.00	20			

Analysis of variance for the different groups of subjects.

dividing the meat as finely as possible with a glass rod flattened on the end.

Method. Ten samples of lean beef were weighed out as usual and treated with five c. c. of water. The meat was then ground as fine as possible with the flattened end of a glass rod. It was stirred and worked until no further division of the particles could be made in this manner. The process of digestion was then continued exactly as in experiment 12. After filtering the N was determined in both the residues and filtrates. The results are shown in table 14.

Observations and Conclusions. There is more variation in duplicates here than in many previous experiments.

Experiment 14.

One more attempt was made to determine whether the coarseness of the sample was responsible for the unsatisfactory variations in results. As it was thought the presence of connective tissue in the meat might be the cause of the trouble this experiment was planned with the following--

Object. To remove as much connective tissue as possible from the meat and compare the digestion results with those from samples which contained the connective tissue.

Method. A rather large portion of meat from sample

Table 15.

Comparative values for meat ground through 40 mesh sieve and that not ground.

Experiment 14.

Exp. No.	Lab. No.	Condition of meat.	Time of digestion.	C. c. of N/10 HCl added in portions of 2 c. c. each at regular intervals.	Per cent not digested.	Per cent digested.
14	2212/1z	Ground.	2 1/2 hrs.	4 c. c.	-----	
"	2212/2z	"	"	"	51.41	
"	2212/3z	"	"	"	62.96	
"	2212/4z	"	"	"	60.92	
"	2212/5z	"	"	"	62.02	
	Average-----					59.33
"	2212/1x	"	"	"		-----
"	2212/2x	"	"	"		52.31
"	2212/3x	"	"	"		39.23
"	2212/4x	"	"	"		41.41
"	2212/5x	"	"	"		34.87
	Average-----					41.96
"	2212/6z	Not ground	"	"	50.30	
"	2212/7z	"	"	"	-----	
"	2212/8z	"	"	"	45.63	
"	2212/9z	"	"	"	52.64	
m	2212/10z	"	"	"	51.57	
	Average-----					50.28
"	2212/6x	"	"	"		51.62
"	2212/7x	"	"	"		-----
"	2212/8x	"	"	"		46.42
"	2212/9x	"	"	"		49.72
"	2212/10x	"	"	"		50.34
	Average-----					49.53

TABLE 1

COMPARISON OF THE RESULTS OF THE SURVEY OF THE FISH AND WILDLIFE SERVICE AND THE BUREAU OF FISHERIES, 1954-1955

UNITED STATES

Year	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463	2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476	2477	2478	2479	2480	2481	2482	2483	2484	2485	2486	2487	2488	2489	2490	2491	2492	2493	2494	2495	2496	2497	2498	2499	2500	2501	2502	2503	2504	2505	2506	2507	2508	2509	2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524	2525	2526	2527	2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540	2541	2542	2543	2544	2545	2546	2547	2548	2549	2550	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583	2584	2585	2586	2587	2588	2589	2590	2591	2592	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606	2607	2608	2609	2610	2611	2612	2613	2614	2615	2616	2617	2618	2619	2620	2621	2622	2623	2624	2625	2626	2627	2628	2629	2630	2631	2632	2633	2634	2635	2636	2637	2638	2639	2640	2641	2642	2643	2644	2645	2646	2647	2648	2649	2650	2651	2652	2653	2654	2655	2656	2657	2658	2659	2660	2661	2662	2663	2664	2665	2666	2667	2668	2669	2670	2671	2672	2673	2674	2675	2676	2677	2678	2679	2680	2681	2682	2683	2684	2685	2686	2687	2688	2689	2690	2691	2692	2693	2694	2695	2696	2697	2698	2699	2700	2701	2702	2703	2704	2705	2706	2707	2708	2709	2710	2711	2712	2713	2714	2715	2716	2717	2718	2719	2720	2721	2722	2723	2724	2725	2726	2727	2728	2729	2730	2731	2732	2733	2734	2735	2736	2737	2738	2739	2740	2741	2742	2743	2744	2745	2746	2747	2748	2749	2750	2751	2752	2753	2754	2755	2756	2757	2758	2759	2760	2761	2762	2763	2764	2765	2766	2767	2768	2769	2770	2771	2772	2773	2774	2775	2776	2777	2778	2779	2780	2781	2782	2783	2784	2785	2786	2787	2788	2789	2790	2791	2792	2793	2794	2795	2796	2797	2798	2799	2800	2801	2802	2803	2804	2805	2806	2807	2808	2809	2810	2811	2812	2813	2814	2815	2816	2817	2818	2819	2820	2821	2822	2823	2824	2825	2826	2827	2828	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838	2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853	2854	2855	2856	2857	2858	2859	2860	2861	2862	2863	2864	2865	2866	2867	2868	2869	2870	2871	2872	2873	2874	2875	2876	2877	2878	2879	2880	2881	2882	2883	2884	2885	2886	2887	2888	2889	2890	2891	2892	2893	2894	2895	2896	2897	2898	2899	2900	2901	2902	2903	2904	2905	2906	2907	2908	2909	2910	2911	2912	2913	2914	2915	2916	2917	2918	2919	2920	2921	2922	2923	2924	2925	2926	2927	2928	2929	2930	2931	2932	2933	2934	2935	2936	2937	2938	2939	2940	2941	2942	2943	2944	2945	2946	2947	2948	2949	2950	2951	2952	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labelled 2212 was placed in a forty mesh sieve and rubbed with a pestel until sufficient meat had passed through the sieve to get five samples for digestion. The meat thus obtained was very finely divided and contained little or no connective tissue. When the samples had been weighed out they were labelled from 2212/1 to 2212/5 inclusive and digested for 2 1/2 hours in 100 c. c. of water containing 1/2 gram of pepsin per liter. At the end of the first hour 2 c% c. of N/10 HCl were added and at the end of the second hour this was repeated. After neutralizing and filtering the N was determined in both the residues and filtrates. Five more samples were obtained from the meat in the original condition (before grinding through sieve). Digestion was carried on as with the first five. The laboratory numbers for this set were from 2212/6 to 2212/10 inclusive.

Observations and Conclusions. There was less uniformity in the results with the ground meat than with the unground. From this data and that obtained in experiment 12 and 13, it was decided that dividing the sample more finely ^{than} that ordinarily used will not remedy the difficulty.

Experiment 15.

Since no remedy for the frequent non-uniformity of duplicates had been discovered when raw meat was digested, the

Table 16.

Digestion of pure beef proteid.

Experiment 15.

Exp. No.	Lab. No.	Time of digestion.	C. c. of N/10 HCl added in portions of 2 c. c. each at regular intervals.	Per cent of undigested. N.	Per cent of digested N. 100-z.
15	2236/1z	2 1/2 hrs.	6 c. c.	89.46	
"	2236/2z	"	"	-----	
"	2236/3z	"	"	88.62	
	Average	-----	-----	89.04	
"	2236/1x	"	"		10.54
"	2236/2x	"	"		-----
"	2236/3x	"	"		11.38
	Average	-----	-----		10.96
"	2236/4z	"	"	76.04	
"	2236/5z	"	"	-----	
"	2236/6z	"	"	75.94	
	Average	-----	-----	75.99	
"	2236/4x	"	"		23.96
"	2236/5x	"	"		-----
"	2236/6x	"	"		24.06
	Average	-----	-----		24.01

last experiment was carried on, with a sample of pure beef proteid. The sample was obtained from Dr. P. F. Trowbridge.

Object. To determine whether the variations in the results would appear after digesting pure beef proteid, the same as with raw beef.

Method. Six samples of well dried proteid were weighed out and labelled from 2236/1 to 2236/6 inclusive. They were digested for 2 1/2 hours in water containing 1/2 gram per liter and at the end of the first hour 2 c. c. N/10 HCl were added. This was repeated at the end of each succeeding half hour until 6 c. c. had been added. When the digestion was completed three samples (No. 2236/1 to 2236/3) were neutralized, evaporated, and filtered as usual. The other three (Nos. 2236/4 to 2236/6 inclusive) were heated on the water bath for half an hour and filtered without neutralization. The residues in all cases were lettered z and the filtrates x. The nitrogen was determined in each and the results given in table 16.

Observations and Conclusions. The per cent proteid digested in each case was small because the proteid is not so easily digested as the meat. All the duplicates however are fairly close, indicating that the difficulties encountered with the meat might be caused by factors in the meat which are not proteid in nature.

In this experiment a comparison is also made between the

method used in the beginning of the present study and that adopted later. In the latter method the solutions were neutralized after digestion and evaporated to small volume before filtering. The difference between the amounts digested in the first and second cases is approximately 14 per cent. This must represent the per cent of acid albumin present in the solution after digestion.

CONCLUSIONS.

The conclusions to be drawn from the fifteen experiments of this study are of two kinds-- those relating to the method of procedure during artificial digestion, and those which refer to the qualitative and quantitative results of such digestion.

They may be tabulated as follows.

1. The method used in the first two experiments is impracticable for two reasons. 1st. The duplicates do not check and 2nd the filtration is too slow.
2. Formalin and phenol are both good antiseptics but formalin is preferred for this work when necessary.
3. Neutralizing the solution after digestion eliminates the difficulties of filtration. It does not make the filtrates perfectly clear however and the duplicates do not check as well as they should.
4. Evaporating on the water bath after neutralization to small volume increases speed of filtration and clearness of filtrates.
5. When KOH is used as the neutralizing agent and litmus paper for the indicator, it is impossible to obtain exactly similar neutral points in the different samples.
6. BaCO_3 is a better neutralizing agent

than KOH.

7. The coarseness of the sample, as used in the first experiments, is not the cause of the variation in the results.

8. Variations in results must be explained in one of two ways-- either the neutralization is not sufficiently accurate to precipitate all of the acid albumin in each case, or there is something in the meat besides the proteid bodies which affects the digestion. The evidences that the first explanation is correct are these: 1. After neutralization there was nearly always more or less turbidity in the filtrates. Some of the acid albumin therefore probably filtered through. 2. When the pure beef proteid was digested the duplicates by the neutralization method were not as good as by the method in which the solutions were not neutralized. The reasons for believing that this is not the cause of the variation in the duplicates, are as follows: 1. The greatest care was taken in the neutralization process to get the conditions the same in the different samples. 2. Only a small per cent of acid albumin is present in solution at any one time when beef is digested, and as careful neutralization must precipitate nearly all of this, there is little chance for error at this point. 3. When BaCO_3 paste is used the filtrates are almost perfectly clear, but the results are not always uniform. 4. When digestion

takes place with acid above the results are always more uniform than when acid pepsin solution is used. This is in spite of the fact that a greater amount of acid albumin is produced, which would tend to make the results more variable. The preponderance of evidence therefore is in favor of the second explanation offered above; namely, that there is something in the meat not of proteid nature, which causes the difficulty.

9. The digestive solution best fitted for determining is weakly acid-- between N/500 and N/100.

10. The products of digestion of meat in acid alone are acid albumin and a small amount of albumoses.

11. When the digestibility of a sample of meat is calculated from the amount of N found in the residues from filtration, practically the same results are obtained as when it is calculated from the N found in the filtrates. The sum of the N in the residues and the filtrates is nearly always very close to the total N of the meat.

12. The products of digestion of meat in a pepsin solution, without any acid, are, albumoses, peptones, and further end products. The albumoses seem to be converted into peptones almost as rapidly as they are formed.

13. When both the acid and pepsin are used the action

is much more rapid than with either one alone. The action of the pepsin however is hindered by a high acidity like N/20. It was found upon reducing the acidity to N/40 that a larger per cent of albumoses were converted into peptones than before.

14. The per cent of albumoses and further end products produced when the pepsin is constant varies with the strength of acid. Results from experiment 8 show that with a digestive fluid containing 1 gram of pepsin solution, the following relations existed:-- In one hour N/20 HCl produced 60 per cent albumoses and 35 per cent further end products. N/40 HCl produced 53 per cent albumoses and 41 per cent further end products. N/100 HCl produced 43 per cent albumoses and 41 per cent further end products.

In closing I wish to express my thanks to Dr. H. S. Grindley and Miss Marion E. Sparks for their assistance in connection with this work.

BIBLIOGRAPHY.

1. Jour. Physiol., 11, 226-263.
2. Am. Jour. Med. Sc., Vol. 133, No. 1, p. 113.
3. Landw. Journ. 28, 1880, pp. 199 and 435.
4. Landw. Jahrbuch, 1890, Vol. 19, pp. 149-187.
5. Report Med. Exp. Station, 1891, p. 338.
6. Zeits. fur Phys. Chem., 1886, V. 10, p. 561, v. 11, p. 1.
7. Landw. vers. stat., v. 44.
8. Landw. vers. stat., v. 46, p. 193-200.
9. Op. Cit., p. 292.
10. Ztschr. Biol. 19, 1883, p. 129.
11. Amer. Chem. Jour. 6, 1884-5, p/ 318.
12. Ztschr. Physiol. Chem. 14, 1890, p. 524.
13. Landw. Vers. Stat. 40, 1892, p. 321.
14. U. S. Dept. of Agr., Bulletin No. Studies of the
effect of different methods of cooking upon the
thoroughness and ease of digestion of meat at the
U. of I. (Unpublished.)
15. The Chem. Changes and Products resulting from Fermentation.
P. 114. R. H. A. Plimmer.
16. The Chem. Changes and Products resulting from Fermentation.
P. 116-117. R. H. A. Plimmer.
17. The Chem. Changes and Products resulting from Fermentation.
P. 120.
18. The Chemical Changes and Products Resulting from Fermentation.
P. 120.

19. Biochemical Researches, vol. 1, p. 460.
20. Chemistry of Proteids. P. 175. Mann.
21. The Chemistry of Flesh. P. 669. Grindley and Emmett.
22. Commercial Organic Analysis. Vol. IV, p. 369.
23. Ber., 17, 2143-2151.
24. Chemistry of Proteids, p. 204. Mann.
25. Pharm. Jour. (3), 25, 914.
26. Commercial Organic Analysis. Vol. IV, pp. 357-358.
27. U. of I. Studies, April, 1903. Artificial Method
for Determining the Ease and Rapidity of the Digestion
of Meats.
28. Verchow's Archiv., (1897), 150, 260-271.
29. D. Arch. f/ Klin. Med., 88, 522-42 (1907).
30. Ak. d. Wiss. (Math. Nat. Classe), 37, 131-84.
31. Zeit. f. Biol. 17, 351-60, 1881.
32. Compt. Rend. Soc. Biol., 61, 282-284 (1906).
33. Compt. Rend. Soc. Biol., 61, 314-16.
34. Viry, Henri. De l'utilisation de la viande congelée.
l'alimentation du Soldat Lyons, 1889, p. 64.
35. Same as 27.
36. Same as 27.
37. U. S. Dept. Ag., Bulletin No. Studies of the Effect
of Different Methods of Cooking upon the Thoroughness
and Ease of digestion of Meat at the U. of I.
(Unpublished.)
38. Commercial Organic Analysis. Vol. 4, p. 355.

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